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HOOKER'S

CHILD'S BOOK

OF

COMMON THINGS.



Glass Blowing.

NEW HAVEN, CONN.:

HENRY H. PECK.

KC 11374



Ludley Cox

1880.

THE
CHILD'S
BOOK OF COMMON THINGS,

For the Use of Primary Schools.

BY WORTHINGTON HOOKER, M. D.,
AUTHOR OF "PHYSICIAN AND PATIENT," "HUMAN PHYSIOLOGY," "THE
CHILD'S BOOK OF NATURE," ETC.

Illustrated by Engravings.

NEW HAVEN:

KC 11374



Entered according to Act of Congress, in the year 1858,

By WORTHINGTON HOOKER.

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P R E F A C E .

THIS book has been made in order to meet a want in primary schools which I have observed in performing my duties as a school visitor. The chief defect in primary instruction, as it is commonly pursued, is *the failure to teach children to think*. Everything is learned almost entirely by rote. The learning of words and things without understanding them, predominates largely at the very outset of education ; and a bad habit is formed which adheres to the pupil in his after course, hindering continually his progress. The result is, that though children are busy observers and thinkers when they begin, ever ready to ask the reasons of things, they lose, in a great measure, this disposition to observe and think, in the treadmill drudgery of a rote education. Hence the fact, that a child is very often a better observer at six or eight years of age than he is at ten or twelve. His spirit of inquiry has been repressed rather than encouraged, and he has gradually given up his questioning of parents and teachers, so commonly fruitless, and with it his observation of things around him.

Some parents and teachers have endeavored to go counter to this prevalent tendency. But they have found great difficulty in doing this, from two causes. First, the books used in primary education are so constructed as to encourage, we may say almost prescribe, learning by rote. Ordinarily they are in the catechetical style, and the answers to the questions are generally so expressed that the child gets no intelligent idea of what is intended to be communicated, and they are therefore merely committed to memory as so many words. Secondly, there are very

few books which introduce primary scholars to the most interesting subjects that may be presented for the exercise of their thought and observation. Such subjects are therefore excluded almost entirely from early education.

Though teachers labor under these difficulties, some of them have succeeded admirably in training their scholars to observe and think, by introducing some general exercises of their own on subjects of the kind referred to, such as air, water, food, clothing, the metals, &c. But even the most successful feel the want of proper books to assist them in doing this. They want to have material collected for them, and moulded by a skillful hand into a proper shape for use in the school-room. They feel, too, that the subjects referred to should, in some measure, be made regular studies, on a par with geography and arithmetic, and not be introduced merely in occasional general exercises.

It is to supply this need in part that I have written this book. I the more readily undertook the task from the great success which has attended the use of my "CHILD'S BOOK OF NATURE," in both schools and families. The "CHILD'S BOOK OF COMMON THINGS" is intended to precede that, most of it being adapted to the very youngest scholars in the primary schools.

In order that I might construct the book aright, I have almost literally made it in the school-room. Most of the subjects I have talked over in some of the primary schools before writing the chapters on them. In doing so I have asked questions, and thus have found out what the little pupils thought on various points. Some of the answers thus obtained I have introduced here and there in the book.

The book can be used in two ways. First, it may be used in teaching scholars that have not yet learned to read. In this case the teacher can select such portions as she thinks that they can understand, and use them in her general exercises, adding such explanations and amplifications as she may see to be necessary. Secondly, it can be used as a book for regular study for scholars who have begun to read. For this latter use there are questions at the end of each chapter. The teacher should not

be confined to these, but should alter and add as she sees is required. Ordinarily I have not made as many questions as the teacher will find it necessary to ask.

Many of the chapters are too long for single lessons. I thought it better to leave the division into lessons to be made by the teacher, and have therefore made the division into chapters according to the subjects treated of.

It is to be hoped that the teacher will not confine herself to the limits of this book, but that she will introduce other subjects into her general exercises. There are many other "common things" besides those that I have here presented, which may be rendered very interesting and profitable in the instruction of her pupils.

So far as it can be done, it will be well for the teacher to bring into the school-room such objects as I have noticed, as, for example, a head of wheat or rye, a cocoon, a duck's foot, and a bird's foot not webbed, some quicksilver, gold leaf, green vitriol, blue vitriol, some types in a little frame, feathers, leaves, a wasp's nest, &c.

I have alluded to the catechetical style of school books as being wrong. It is so because it renders learning by rote almost a matter of course. *It is not the natural way of communicating knowledge.* If you wish to make a child understand anything, you *talk* to him about it. So, too, our school books should talk to children,—more concisely, it is true, than is done in common conversation,—but in the same general style. The answers can be found to the appended questions in what has thus been told to them. This is just as a lecturer examines his hearers on the previous lecture. And a lecture in the form of question and answer would be no more improper than a book written in this style. In both cases instruction is to be communicated, and the mode of doing it should be essentially the same.

It will probably be objected by some to the introduction of this book into the primary schools, that there are already studies enough, and that there is no time to spare for a new study. To this I reply, that a large portion of the geography and all the

grammar that very young scholars learn, is of no use to them, and had better therefore be supplanted by something which is of practical value. Now if any teacher will run over the table of contents of this book, he will say at once, that the "common things" treated of here ought to be understood by the pupils in our schools. - And it is folly to let a child grow up in ignorance of them, while his memory is burdened with statistical facts about the ends of the earth, which properly belong only to a gazetteer, and never should be seen on the pages of a *child's* geography. Surely it is better to teach a child what he can understand about the air he breathes, the water he drinks, the food he eats, and the things which he sees in constant use about him, than to oblige him to commit to memory the number of square miles in various countries, and their population,—numbers which are so large that a little child can have no idea of them.

WORTHINGTON HOOKER.

NEW HAVEN, CONN., *June*, 1858.

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CHAPTER I.

AIR.

WHAT is it that makes a foot-ball so hard? It is the air that is inside. If you prick a hole in it, it is no longer hard, because the air goes out of the hole.

There is a way of making the air in a bladder burst it. It is by heating it before a fire, when it is full of air. The heat makes the air swell. If you heat it long enough, the air will swell so much that it will burst open the bladder. You can not do this with an India-rubber ball. The reason is, that this will stretch as the air swells; but the bladder can not stretch much, and so it breaks.

Air that is swelled by heat is lighter than the air that is around it. So it always goes up. You know how the air blows up from the registers of a furnace. This is the heated air going up, because it is light. Sometimes boys fix paper wind-mills on a stove-pipe, and they whirl around very briskly when there is a good fire. The reason is this. The air about the pipe is made very light by the heat, and so flies up. As it flies up it hits the paper wind-mills, and makes them whirl.

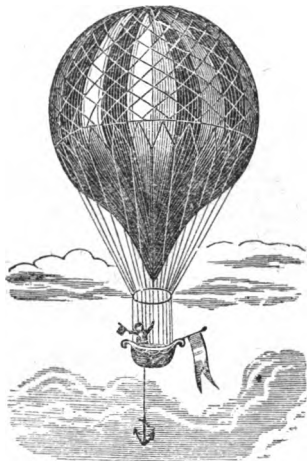
Air is never still. It is moving even when it seems to be very still. I will tell you how you can prove this. Let a room be darkened by shutting up the shutters. Then open one a little so that the light can come in just there. Sit down, now, and look where the light comes in. You will see little motes moving about, up and down and around. Why is this? Do the motes move of themselves? No; it is the moving air that moves them about.

When you are walking, the air is turned by your body to the one side and the other; and then it closes up behind you. It is just as it is with any one pushing his way through a crowd. He pushes the people to the one side and the other, and then they close together behind him. The only difference is, that it is easier to push air away than it is to push people.

You do the same thing to water when you walk in it. You push it to the one side and the other as you do the air; and the water closes up behind you as the air does. The water is not moved by your body as easily as the air is. This is the reason that you can walk easier in air than you can in water. You can not run in water at all, because you can not move it out of the way easily enough for that. Walking in water is not called walking, but wading.

Air is so light, that it is very common to say of light things, that they are as light as air. But there are some things that are lighter than air is,

The gas that we burn is an air that is lighter than the air that we breathe. Balloons are filled with a very light gas. This is the reason that they go up so swiftly in the air. Here is a picture of one. It



is so large that it carries up a man in the car that is fastened to it.

What makes a foot-ball so hard? How do you know what it is? How can you make air burst a bladder? Why can not you do the same with an India rubber foot-ball? Why does heated air always go up? What makes air blow up from the registers of a furnace? Tell about the paper wind mills. Is air ever still? Is it still when it seems to be? How can you prove that it is not? What do you do to the air when you walk? How is this like going through a crowd? How is walking in water like walking in air? What is walking in water called? What is said about the lightness of air? What about the gas that we burn? Why does a balloon go up?

CHAPTER II.



WIND.

WIND is air moving. When it moves but little, we call it a gentle breeze. When it moves very fast indeed, we say that it blows a gale. When it moves by fits and starts, we say that it blows in gusts. When it moves in a whirl, and not straight along, we call it a whirlwind.

The wind blows the ships along. The sails are put up for the wind to blow upon. Why are sails needed? Why can not the wind blow the ship fast enough without them? It is because the air is a very light thing, and the ship is very heavy. For

this reason a little air can not move the ship. You must have a great deal of the air to do it. A great deal of it must *take hold* of the ship, as we may say. And the sails are great broad handles for the air to press upon. They are so large that a great deal of the air presses on them, and makes the ship move along in the water. It is the moving air pressing against the kite that makes it go up. It is the moving air that works the wind-mills. The fans of a wind-mill, as you see, are made very large, so that a great deal of air may take hold of them.



If the air moves very fast indeed, it will not do to have all the sails of a ship up. It would drive the vessel too fast over the high waves. Then the sailors take down the sails. If they did not, the wind would push the ship so hard that it would tip it over into the sea, and it would sink.

The air is generally a very gentle thing. It gets out of the way easily as you walk through it. There is nothing so gentle as a gentle breeze as it

blows upon your cheek. But the air that is commonly so gentle is very rough and violent when it moves fast. It is just so with anything else. You put out your hand slowly and touch some one. The touch is as gentle as the gentle breeze. But make your hand move fast and hit some one with it, and it is a violent blow. It is like the fast moving air.

Your hand may be made to move so fast as to knock some one down. So the wind often moves so fast as to slam doors, raise water into high waves, drive ships on to rocks, and even blow down houses, and tear up trees by the roots.

I have told you how easy it commonly is to walk through the air. But sometimes it is very hard to do it. It is when the air is moving very fast, and you are walking against it. This is like passing through a crowd that is coming directly towards you. But if you are going the same way with the air, it is very easy to get along. The wind then pushes you along as it does the ships. It is like being pushed along by a crowd of people.

What is wind? What is a gentle breeze? What is a gale? What are gusts of wind? What is a whirlwind? What does the wind do to ships? Why are sails needed? What is said about the sails being handles? Tell about the kite. And about the wind-mill. When do the sailors take down the sails? What would happen if they do not? What is said about the air's being gentle? When is it rough? When is your hand like a gentle breeze? When is it like fast moving air? What can your hand do when it moves *very* fast? What can the air do when it moves *very* fast? When is it hard to walk through air? What is it like? How is it when you are going the same way with the air? What is it like?

CHAPTER III.

AIR AND FIRE.

A FIRE will not burn unless the air can come to it. You have seen air-tight stoves. They are not really air-tight. Some air can get in. If it could not, the fire would not burn at all. When the stove is shut up, the wood burns very slowly, because but little air gets in. Open the door, and the fire lights up very briskly, because so much air is let in upon it.

Do you know why people blow a fire with a bellows? To make it burn well, you will say. But why does this make it burn? It is because the bellows sends the air to the fire so fast. In this way a great deal of air goes to the fire in a short time.

If a girl's clothes should take fire, how is the best way to put them out? Should she run to where there is water? No. Before she got to the water the air would set her clothes to burning very much. Something must be done very quick to put the fire out. What is it that must be done? Let her be all covered up with something at once. If people are with her, let her lay herself down on the floor, and let them wrap shawls, coats, a rug, or anything else that is thick and will not burn easily, close around

her. This will put out the fire. Why? Because it shuts the air out from the burning clothes.

I knew a very great fire to happen once because a man did not understand such things. Some shavings got on fire in a carpenter's shop. There was a loose door standing close by. Now if the man had taken this, and laid it very carefully down on the shavings, it would have put the fire out at once. Why would it? Because the door would shut out the air from the shavings. It would *smother* the fire, as we say. But he did not do this. He caught up the door very quickly, and *threw* it down on the shavings. This blew the air down upon them, and so scattered them about very much. Only a few of them were under the door when it was fairly down. The scattered shavings set the other shavings about the shop on fire. Soon the whole shop was in a blaze; and this set fire to a long block of buildings. This was one of the greatest fires they ever had in the city of Boston. And all this might have been saved, if the man in the shop had only laid that door down carefully. How well it is for people to understand just how to do things.

Now I will tell you about a man that did understand things. As he was walking along in the country, a woman called to him from a house, "Do come in quick, sir, the house is on fire." He ran in and saw the fire blazing all up the wood-work over the fire place. A pail of water stood on the floor, but

the woman trembled so with fright that she could not throw it on the fire. She asked him to throw it on. He did not, but asked her if she had any more water. "No," cried she, "but do throw it on." "Is there any more water close by?" asked he, "No, no, there is none but at the spring, a good way off, but do throw it on." "Give me your mop," said he. "Throw it on," said she, "do throw it on." "Give me your mop," said he again. She then got it for him; and he, with the water in the pail, mopped the fire all out in a very few moments.

Now, if he had thrown the water on, he could not have made it go all over the blazing boards. Then before they could bring any more water from the spring, the fire would have spread and the house would have burned down.

How is it that water puts out fire? It covers up the burning things, so that the air cannot get to them, and so smothers the fire. Besides, it cools down the heat. It is in these two ways that water puts out fire.

It is not merely because the water wets the burning things, that it puts the fire out. Oil can wet them—so can spirit. But these would take fire and burn if you threw them on. The water is different from them in this. While it wets the burning things, it will not itself burn.

We cannot live without air. We should die if we did not keep breathing air into our lungs all the

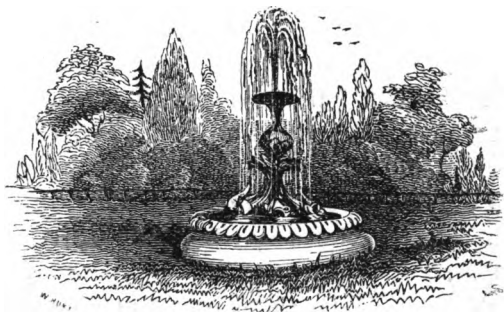
time. You are not old enough yet to understand how it is that the air keeps you alive. You will learn about that by-and-by.

How does drowning kill a person? The water does not kill him by getting inside of him. He dies because no air can get into his lungs. It is shut out by the water.

There are some animals that can live in the water. The fishes do, you know. And they can not live in air as we do. God made us in such a way that we can live in the air; and he made them in such a way that they can live in water.

What is needed to have a fire burn? Are air-tight stoves really air-tight? What would happen to the fire if no air at all could get in? Why does the fire burn so well when the door is open? Why does blowing a fire make it burn? If any one's clothes take fire how would you put the fire out? What kind of clothes must you put round her? Why would not thin ones do? Why must you put the clothes *close* around her? Tell about the fire in the joiner's shop, and what the man did. How did he do wrong? Tell about the fire in a house. Why did not the man throw on the water? How does water put out fire? Why could you not put out a fire by throwing oil or spirit on? What is said about living without air? How does drowning kill any one? Why can fishes live in water and not in air? Why can not we live in water?

CHAPTER IV.



WATER AND CLOUDS.

If you spread a wet cloth out on the grass in a bright day, it soon dries. How does it dry? **The** water that is in the cloth leaves it. Where does it go? A little girl in a school-house, where I asked this question, said, that it went into the ground. But, said I, how is it with clothes hanging on the line? The water does not go into the ground from them. You do not see it drop. No; that is not the way that it leaves the clothes. It flies from them off up into the air.

Water is flying up into the air from everything that is wet. It goes up from houses, and fences, and

grass and leaves, and even from the ground. It goes up, too, from every puddle, and pond, and brook, and river, and sea. A great deal of water goes up from all these things. I will tell you soon what becomes of it.

Water goes up from the skins of all animals. It goes up from your skin. Suppose you are wet with perspiration ; sit still a little while, and the perspiration is all gone. It has flown off into the air. It will go off quicker if you fan yourself. This is because you make the air come faster to you. A great deal of air comes to your skin in this way in a little time, and carries off the moisture.

Water goes up into the air from your lungs. You are all the time breathing out water with air. If you breathe on a window-pane, it becomes wet in a short time with the water from your breath. You wake up in a cold winter's morning, and see the window of your bed-room covered with frost. Most of that frost is made from water that you have breathed out.

When you write, the ink soon dries. This is because the water of the ink goes off into the air, and leaves the black part of the ink on the paper.

A little girl once asked me *how* the water goes up. Well, that is something of a question. Let us look at it. The water is heavier than air. It cannot go up of itself. So you can not go off up into the air, because you are heavier than air. But a balloon can

go up, because it is lighter than air. Now you can go up with the balloon ; and so can the water go up with the air. The air, then, is a kind of balloon for the water, to carry it up.

You can sometimes see water going up in the air. If you go out in a bright, warm, sunny morning, when the fences and houses are wet, how they smoke, as people say. What makes this smoke ? It is the water going up. The air, heated by the sun, is taking up a great deal of water now. The warmer the air is, the more water it will carry off. This is the reason that things dry so quickly in a hot summer's day.

If you iron a cloth with a hot flat-iron, it dries it. How is this ? Does the water leave the cloth and go to the flat-iron ? No ; there is no moisture on the iron. What becomes of it then ? It must go somewhere. The flat-iron heats the water in the cloth and the air that is around the iron, and off the air and the water fly together. This is what makes the cloth smoke as you iron it. The smoke is the water turned into steam by the heat of the iron.

Water is always ready to fly off into the air. It is like a bird, ever ready to go if there is a way. If you bottle it up, you can keep it. But leave the cork out, and the water is like a bird with the door of its cage open. It will not stay in the bottle. That which is the nearest to the mouth of the bottle will fly off first into the air, and it will keep coming out

all the time, as long as the bottle is open. If you let it stand open long enough, all the water will fly off.

I once asked a school if there was any other way of keeping water from flying off, besides bottling it up. A little girl said, yes, freezing it. She answered right. The air can not take up a lump of ice and carry it off. It can take water up only when it is divided up very finely. Each little atom of air can take up only a very little of the water. And so long as water is ice, it can not be divided up finely enough to go up in the air.

What becomes of all the water that goes up in the air? A great deal of it makes the clouds. Did you ever think, when you are looking up at a cloud, that perhaps some of the water that is there came from your breath, or from your skin? It may be so, for the water in the clouds comes from all kinds of things.

What variety there is in the shapes of clouds! Some are piled up in heaps. Some are stretched out a long distance. Some are very heavy, and some are very light and thin. In the thin, feathery clouds, there is but little water. But there is nothing but water in any of the clouds. This is all that they are made of.

How beautiful the clouds sometimes are! What a bright silvery edge the sun often gives them! What bright colors they sometimes have just before

the sun rises in the morning ! Did you ever think that all these beautiful colors are made by the sun shining on water ? This is so, for there is nothing there but water for it to shine upon. The rainbow, too, is made by the sun shining on water. In what way it makes it, you are not old enough yet to understand.

What happens to a wet cloth spread out on the grass ? What did a little girl say about this ? Why was not she right ? What does water go up into the air from ? How do you know that water goes up from your skin ? Why does fanning make it go up faster ? From what else in you does it go up ? How do you know it goes up from your lungs ? Tell about the frost on the window. Tell about ink. Can water go up in the air of itself ? Why not ? How can you go up in the air ? How like this does the water go up ? When can you see water go up ? Why do things dry so quick in a hot day ? How does ironing a cloth dry it ? What is the smoke that you see go up about the flat-iron ? How is water like a bird ? How can you keep it from flying off ? What will happen if you leave the bottle uncorked ? What other way is there of keeping water from flying off ? Why cannot ice go off into the air ? What becomes of the water that goes up in the air ? Do you help in any way to make clouds ? Tell about the different shapes of clouds. What are clouds made of ? Tell about the beauty of the clouds. How is all this beauty made ? How is the rainbow made ?

CHAPTER V.

RAIN AND DEW.

THE water that goes up and makes the clouds, comes down again. If it did not come down, the ground and everything else would become very dry. The ponds, and brooks, and rivers, and seas, would all dry up. All the grass, and plants, and trees, would die. All animals would die too. If the water was always going up, and none coming down, nothing could live.

Sometimes it does not rain for a long time. Then we have what is called a drought. The grass becomes quite dry. Some of the plants droop, and stop growing. Some of the leaves on them dry up. The leaves on the trees lose their bright green color. The ground becomes parched in the hot sun. There are no puddles to be seen anywhere. The water in the ponds and rivers is very low, and some of the brooks and small streams are dry.

At such a time the gardener waters some of his plants at evening. Why does he do this at evening rather than in the heat of the day? It is because if he does it when the sun is up, the heat of the

sun will make much of the water go off up into the air. He wants to have the plants drink up all the water they can. He does not want to have the sun steal it away from them.

In a bright summer's day, the grass and the leaves of the plants and trees are quite dry. This is because the water has gone from them up in the hot air. But go out the next morning, and the leaves and grass are wet with dew. What is the dew? It is some of the water that went up in the air the day before, come back again. But how has it come back? Not by raining down, for there has been no rain. The water that makes the dew has not been up high enough to form clouds. It is water in the air close to the ground that makes dew.

I will tell you how the dew is made. When there is a great deal of water in the air, water will gather on anything that is very cold. This is the reason that there is water on the outside of a tumbler of cold water in a hot summer's day. As I have told you before, there is a great deal of water in the air then. The hot sun has made it go up from everything. The air that is all around the tumbler is full of it. And the water gathers from this air on the tumbler because it is so cold. It is a real dew on the tumbler.

This dew will not form unless the tumbler has cold water in it. So it seems to people that do not understand it, as if the water sweated through the

tumbler. They say, see how the tumbler sweats. But water cannot go through glass, you know. What then does the water in the tumbler do? It only serves to make the tumbler cold. If you put warm water into a tumbler, there will be no gathering of water on the outside. You can try the experiment in a hot day.

Now this will show you how the dew forms on the ground, and grass, and other things at night. The air gets full of water in the hot day. Now, at night, the ground, and grass, and leaves, grow cool. Then the water in the air gathers on them as it does on a cold tumbler in a hot day.

What a good thing the dew is! In a dry time, when there is no rain for many days, the plants would droop very much if there was no dew. The dew at night revives them very much after a hot day has parched them. It is drink to the thirsty plants.

Does the water that goes up to make clouds stay there? What would happen if it did not come down? Tell all about a drought. When does the gardener water his plants? Why does he not do it in the middle of the day? Why are grass and other things dry in a bright warm day? Why are they wet the next morning? Where does the water that makes the dew come from? Does any of it come from the clouds? What do we see on a tumbler of cold water in a hot day? Where do the drops of water come from? Why is the air so full of water in a hot day? What do some people think about the water on tumblers? Do you think so? Why not? Why will not the drops be on a tumbler if there is no cold water in it? Tell about the experiment with two tumblers. Now tell why the dew gathers on the grass and other things. What good does the dew do?

CHAPTER VI

RAIN, SNOW, AND HAIL

WHEN it rains, it is water falling from the clouds. But it does not always rain when it is cloudy. Why is this? In a school where I asked this question, the answer of one of the boys was, that it rains because the clouds get so full that they burst. But this can not be so. For sometimes it rains when the clouds are very thin and sometimes it does not rain when they are very heavy. Now when they are heavy they are full of water. And if this boy's reason was the right one, it ought always to rain when they are heavy, and never when they are light. There must be some other reason, then. There must be something done to the clouds to make the rain come. You are not old enough to understand all about this. But there are some things about it that you can understand.

The water, as you see it in the clouds, is not in drops. It is like fog. If it were in drops it would fall, for drops cannot stay up in the air. Now when it rains, some of the water in the clouds is made into drops, and then down it comes.

But what makes the water in the clouds into drops? It is the cold that does it. But how? It does it by giving the clouds a good pinching. How funny that is, you will say. Does the cold really pinch the clouds? Yes; it presses some of the water of the clouds together in drops, and then they fall.

You have sometimes heard people talk about being pinched with cold. It does really pinch us when we are much chilled by it. It shrinks us up. You can see this in the fingers. Suppose you have a ring on a finger, and it sets very tight. Now if the finger should be very cold indeed, the ring would drop off very easily. This is because the cold pinches or shrinks up the finger.

Perhaps you have seen how the cold pinches the quicksilver in the thermometer. When it is warm weather, the quicksilver is quite high up in the glass tube. But when it grows cold, the quicksilver falls. It is because the cold pinches or shrinks it, and it does not need so much room.

Suppose that you have a wet sponge in your hand. Though there is a good deal of water in it, it does not drip. The water stays there as it does in the clouds. Squeeze it now, and the water will drop from it in a shower. The cold does to the clouds pretty much what you do to the sponge. The water is not in drops in the sponge. It is all divided up fine, and is mixed up with the sponge. But

when you squeeze it, you make the water come out from the sponge in drops, and the drops fall.

You remember what I told you about the cold tumbler in a hot day. The water in the air around it is not in drops. You can not see it because it is so finely divided up in the air. It is divided up more finely than it is in the clouds. But the cold of the tumbler gathers it into drops. Just so the cold gathers the water in the clouds into drops when it rains.

But the water does not always come down as rain. Sometimes it snows or hails. How is this? Why, then the cold gives the clouds more of a pinch than when it rains. Sometimes the hail comes down all of a sudden in summer. A very quick and hard pinch do the clouds get from the cold then.

In some countries it is so warm all the year round that the people there never see snow. When persons who have always lived in such countries, first see snow, it looks very strangely to them. A little girl that came from such a country to live here, woke up one morning, and saw everything out doors covered with snow. She did not understand it, for no one had told her about it. At first she thought God had sprinkled flour all around in the night. She could not think of anything else that it could be. But while she was thinking about it, she saw some of the boys snow-balling. Then she knew it could not be flour. She could hardly believe that the

beautiful white snow was made of water. But they showed her that it was by melting some of the snow.

There are some countries where it is so cold the year round, that the people always see ice and snow. Very few things can grow in the cold summers they have in such countries.

When mountains are very high indeed, their tops are covered with snow and ice through summer as well as winter. This is so even when the mountain is in a warm country. So you may be in hot summer weather at the foot of the mountain, but by going up the mountain, in a few hours you may be where you will want overcoats and furs to keep you warm.

Does it always rain when there are clouds? Tell about the boy's reason for its raining. How was he wrong? Is the water in clouds in drops? What is it like? What would the water do if it were in drops? What is done to the clouds when it rains? Does the cold pinch us sometimes? Tell about the ring on the finger? Tell about the thermometer. If you hold up a wet sponge, why does the water stay in it? How is this like the clouds when it does not rain? What does squeezing the sponge do? How is this like the cold's making it rain? How is the water in a hot day around a tumbler? Which is most finely divided up, this or the water in the clouds? How does the cold in the tumbler do like cold up in the clouds? What does the cold do when it snows or hails? Why is there no snow in some countries? Tell about the little girl when she first saw snow. Tell about some very cold countries. Tell about some very high mountains.

CHAPTER VII.



WATER GOES EVERYWHERE.

ALL the water that we see running in the brooks and rivers has come from the clouds. It came from there as rain or snow. All the water in the springs and wells also came from the clouds. When it rains the water sinks into the ground, and so fills the springs and the wells.

The brooks and the rivers are filled from the springs. It takes a great many springs to make a brook. And then it takes a great many brooks to make a river.

If you start where a river begins, and follow it along, you find that it is growing larger all the time. This is because there are brooks and streams empty-

ing into it all the way. If the river is a long one, it is very large when it empties into the sea. A sea is like a pond, only it is very, very much larger. It is kept full of water by the rivers that empty into it.

You have heard people talk about freshets. We have a freshet when a great deal of rain comes in the spring. As the ground is frozen, the rain cannot sink into the earth. So it runs right into the brooks and rivers and fills them very full.

Water, you see, is everywhere in motion. The water that you see in the river to-day has travelled from a great way off. How swiftly it is going by you now. To-morrow it will be far away in the sea. But the river will be as full to-morrow as it is to-day, for the water is always moving.

Water moves in many different ways. It runs, and leaps, and dances, and sails, and falls, and flies. It runs in the brooks and rivers. It leaps in the water-falls. It sails along in the clouds. It falls from the clouds in rain, or snow, or hail. And it flies up from the earth and makes the clouds and the fog.

Sometimes it is noisy in its motion, and sometimes it is silent. It patters on the roof when it rains. It babbles in the brook. It roars in the waterfall, and when it rises in great waves in the sea. But it is silent when it sails along in the clouds, and as it flies up in the air.

Water goes everywhere. There is no knowing where the water that you are breathing out now

may go. Some of it may go off far up into the air, and help to make a cloud. Then there is no knowing where it may go in the cloud, and where it may drop in rain. What went up from your breath may drop on the cheek of some child a long way off from you.

Water as it travels about gets very much scattered. It does not keep all together as it travels. And just think the next time that you drink water, how what you are swallowing has been about in various places. Some has come from one place, and some from another. It has come, too, from all sorts of company. But you know that water, if it goes up in the air from bad company, goes up pure. It is water alone that goes up into the clouds, and then rains down. Nothing else can go up there with it. If it goes up from dirt, it takes none of the dirt with it. It leaves its bad company behind.

Where does the water in the brooks and rivers come from? How are the springs and wells filled? How is a brook made? How is a river made? Why does a river grow larger as it goes to the sea? What is a sea like? How is it different from a pond? What keeps a sea full of water? Tell how a freshet is made. Tell what is said about the water in a river. Where does water run? Where does it leap? What makes it dance? Where do you see it sail? When do you see it fall? When does it fly? Tell about its being noisy. When does it move silently? Is there any place where water does not go? Can you tell where the water you are breathing out now will go? Suppose it goes up into a cloud, can you tell where it will drop? Does the water as it travels keep together? What is said about the water that you swallow? Does anything go up with water into the clouds? How is it when water goes up from dirt?

CHAPTER VIII.

WHAT WATER IS GOOD FOR.

WATER is so common a thing that most people do not think how good a thing it is. They drink it every day, and use it in various ways, and they do not thank God for giving it to them so abundantly. If they should be without any water for some time, they would find out how great a blessing it is. They would find that they could not live long without it.

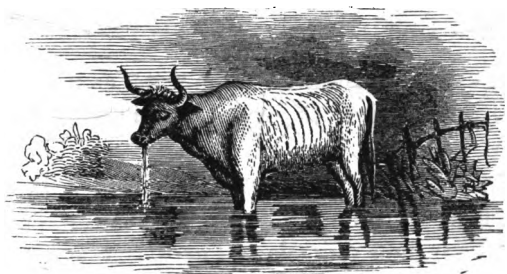
Let us see in how many ways we use water. Then we shall know what a good thing it is.

We can not keep clean without it. What a comfort it is to be clean ! How filthy people are that do not wash their clothes and their skins very often ! And filth makes sickness. It is very healthy to play or to work in the dirt. But it is not healthy to keep dirty after we get through with our play or work.

Many people think that water is a poor kind of drink. They are always mixing other things with it, or they drink something else instead of water. But when we are thirsty, no drink is so refreshing as water is. Water is the only drink that we can

not do without. Those that drink other things must drink some water. They could not live without it. But there are many that drink nothing but water, and do not feel the need of any other drink.

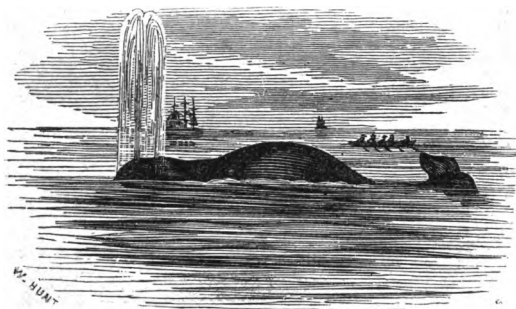
The animals drink nothing but water. They will not drink anything else. Here is an ox that has just been drinking. He stands there as if he did not want to go away from a place where he has been so much refreshed. Do you think that he would drink rum, or gin, or wine? No, he would not touch it. He would shake his head at it, as if to say that is not the drink for me.



It is the drink of plants, too. You remember that I told you in Chapter IV how the plants are refreshed by the dew. It is because they drink it. And you know how the plants and trees are brightened up by a shower after a dry time. This is because they are well washed, and are having a good drink of water after being so very thirsty.

There are a great many animals very useful to us

that live in the water. There are the fishes, and oysters, and clams that we eat. Then we get oil from the great whales that live in the water. Here is a whale spouting up water like a fountain.



We sail on the water. The water as it runs, turns water-wheels to work machinery, in mills and factories.

There is water in almost everything. There is a great deal of water in all things that grow—in trees, and plants, and animals. There is much water in many of the fruits. Most of the juice of such fruits as apples and peaches is water. The watermelon is called by that name because it has so much water in it. The richest milk has considerable water in it as it comes from the cow. Poor milk has more. Some people put water in milk, and so cheat in selling it.

There is a great deal of water in you. It is the water that keeps your joints from being stiff, and

your skin from being dry. More than three-quarters of your blood is water. It would stop running in your veins if there was no water in it.

If you stir some sugar in water, in a little time it is all out of sight. We say that it is *dissolved* in the water. What does this mean? The sugar is there, for you can taste it. But it is so finely divided up that you cannot see it. It is finer than the finest powdered sugar.

The sugar, we may say, hides itself in the water. But a great deal cannot be hid by it. If you put in too much, some of it will not be dissolved, but will stay at the bottom.

You remember that I told you in Chapter IV how water flies off into the air. Suppose you have some sugar dissolved in water in a cup. If you let it stand long enough, the water will all fly away from the sugar, and leave it sticking to the inside of the cup.

Salt, and many other things, can be dissolved in water. Water is of great use to us in this way. But there are some things that water can not dissolve. You can mix flour in water by stirring it up, but it will not dissolve in it. The water will not hide it, as it does sugar and salt. It will not divide it up fine enough to put it out of sight. If your mother mixes some magnesia in sugar and water for you to take, the magnesia does not dissolve as the sugar does. It only mixes with the water as she stirs it.

If you let it stand, it will sink to the bottom of the cup.

Do most people think much about water? Tell about this. What would they find out if they should be without water? What is said about keeping clean? What about playing and working in dirt? What about being clean after it? What do many people think about water as a drink? What drink does us the most good when we are thirsty? Can we do without water as a drink? Can we do without other drinks? What do animals drink? Tell about the ox? Why are plants refreshed by dew? How does the rain do them so much good after a dry time? What animals that we eat live in water? From what animals do we get oil? What do we do on the water? What does the water turn for us? Is there water only in a few things? What is said about things that grow? What about fruits? Tell about apples and peaches? Why does the water melon have this name? Is there water in milk? Is there much or little water in you? What good does it do? How much of your blood is water? What would happen if there was no water in it? When you dissolve sugar in water, why cannot you see it? Can the water dissolve much sugar? If you leave a cup standing with sugared water in it, what will happen? Can many things be dissolved in water? How is it about flour? Tell about magnesia

CHAPTER IX.

BREAD.

It seems a very quick and easy thing to make bread. But a great many things have to be done to get ready to make it. And it takes a long while to do them. To give you the bread that you eat to-day they had to begin some months ago. I will tell you about this.

Bread is made from flour. But what is flour? It is a fine powder made by grinding grains that have grown out in the field. These grains are either wheat or rye. The wheat flour makes white bread ; but the bread made from rye flour is rather dark. Indian meal is sometimes used in making a brown colored bread, by mixing it with rye flour. Indian meal is made by grinding corn.

I will tell you all the different things that must be done to give us bread.

First, the seed must be planted in the ground. This seed is some of the grain that was not ground into flour. It is saved on purpose for planting. After a little while, there shoot up small green stalks from the seed. There is no grain on them at

first. They grow to be very tall, and then we see the heads of wheat on their tops.

A stalk of grain is very beautiful. It stands up tall and straight. Its top is well loaded with the grain. Take a head of wheat or rye and look at it. See how prettily the grains are fastened around the top of the stalk. Each grain is covered up with a husk. And see those long spikes standing out from the ends of the husks. They are called the beard.

I call them spikes because they are so strong. These spikes are very curiously made. Take one between your fingers, and see how rough it is. Try to pass your finger down from the point of it to the husk. You can not do it. It is because there are a great many little prickles on it all pointing one way. You can pass your finger from the husk towards the end, for that is the way the prickles point.

In Fig. 1, you see one of the husks and its spikes. In Fig. 2, you see the end of the spike as it looked to me through the microscope. Fig. 3, shows you the little end that I looked at. You can not

see any prickles on it. But the microscope made it look so large that I could see all the prickles.



Fig. 1

Fig. 2

Fig. 3

How nicely made each of these spikes is with all its prickles. It would take a man a great while to make a little thing like this. But how many there are in a head of grain! Count them. And then think that there are so many of these curiously made things in a field of grain that you never can count them.

Did you ever look over a field of grain when the wind is blowing briskly? How those tall stalks with their heavy heads bend! But they do not break. They are very strong, though they are so slender. And how beautifully the whole field looks as the wind makes waves over it. They are very much like the waves that it makes in water.

After the grain is ripe, they cut it with sickles. This they call reaping. Then they gather it together in bundles, or sheaves, as they call them. Do you remember Joseph's dream about sheaves that he told his brothers? If you do you can tell it to your teacher.

The sheaves are carried home to the barn. There they are threshed. This beats out the grains from the husks. This is sometimes done in a machine instead of threshing. The machine gets the grain out of the husks by giving them a good picking with some iron points.

The grain is then gathered up. But there is a great deal of chaff with it. This chaff is pieces of the husks. These must be got rid of, so that we

may have the grains of wheat alone. This is done by a winnowing machine. It is a machine with swift moving fans in it. As the wheat goes through the machine, these fans blow away all the chaff. They do not blow away the grain, because that is heavy. The grain falls, while the chaff flies away in the wind that the fans make.

Now we have got the grain. What is to be done next? The grain is carried to a mill to be ground into flour. It is ground between stones which rub on each other.

Well, it is flour now. But it is not the white flour that we make wheat bread of. It is unbolted flour, as they call it. It is such flour as they make Graham bread of. There is bran with it. What is this bran? If you look at a grain of wheat or rye, you will see that it has a brown skin. It is little bits of this skin that make the bran.

This bran is got rid of by sifting, or bolting, as it is called. The fine part of the flour is the powder of the grain. This passes through the sieve, while the bran stays behind. The bran is not fine enough to go through the sieve.

Now the flour is put into barrels, and is ready to be sold. We make bread of this. To do this, the flour is wet, and yeast is mixed with it. It must have a good kneading, so as to mix it well. The yeast swells up the dough, as it is called, or makes it rise, as we say. It is not bread yet. Baking it

makes it bread. The holes that you see in bread, come from the swelling by the yeast.

In the Bible, yeast is called leaven. It takes but little of it to make a great deal of bread rise. So the Bible says, "a little leaven leaveneth the whole lump." You have read in the Bible about unleavened bread. This is bread that has no yeast, or leaven, in it.

See, now, how many things have to be done before we can get bread. They are, planting—growing—reaping—threshing—winnowing—grinding—bolting—mixing up with yeast and water—baking.

What is said about getting ready to make bread? What is bread made of? What is flour? What is said about wheat flour and rye flour? What is brown bread made of? What is Indian meal? In getting ready to make bread, what is the first thing to be done? What is planted? What grow up from the seed? Tell about the stalks of grain. And about the wheat heads. What is the beard of the wheat? Tell about the spikes. Which way do the prickles on them point? Tell about passing your finger along one of them. Could a man make one of these spikes in a little time? Can you count all the spikes in a field of grain? Tell about the grain when the wind blows. What is done when the grain is ripe? Tell about the sheaves. What was Joseph's dream? What does threshing the grain do? How does the threshing machine get the grains out of the husks? What is chaff? Tell about winnowing. How is the grain ground? What is bran? What is unbolted flour? What is Graham bread? How is the bran got rid of? How is bread made out of the flour? What is dough? What does the yeast do to it? What is the last thing done in making bread? What is leaven? What does the Bible say about it? What is unleavened bread? Now how many things have to be done to get bread? What are they?

CHAPTER X.

MILK.

How beautiful is the clean white milk that you drink! What is it made from? The grass and other things that the cow eats, you will say. But does the grass that the cow is so busy eating in the pasture, turn right into milk? Let us see about this. The cow's bag, where the milk is, is a great way off from her stomach, where the grass is. Now, do you think that the grass is made into milk in the stomach, and that the milk is then carried by a sort of pipe, down into the bag? No, that is not the way that it is done.

But in some way the milk comes from the grass. How is this? I will tell you a little about it. The grass is first changed into blood. Then the blood goes by a great many pipes to the bag, and there milk is made from it. The bag, then, is the milk factory. How strange it is that such a red thing as blood should be made out of green grass! How strange it is, too, that the white milk should be made out of red blood!

But there is something about this more strange

still. What do you think the cow's horns are made from? They are made from the blood. What! the horns made out of the same thing that the milk is? Yes. And so are the hair, the hoofs, and everything else in the cow. She was a little calf once. She has grown up to be a cow by eating. Every time that she ate, there was more blood made. So everything in her was made larger and larger from this blood.

And some things were made out of blood that she did not have at first. When she was a little calf she had no horns. But as she grew, the horns were made out of the blood that came to the head by the pipes.

I have something more to tell you about the cow's milk. If you drink it, blood is made from it in you, and it makes you grow. So you see, in the cow's bag, blood is changed into milk, and then the milk in you is changed back into blood again.

Do you suppose that if you should eat grass it would turn into blood? No. The cow must first eat it and make milk out of it, and then it will make blood in you.

The milk of some other animals besides the cow is sometimes used. In some countries, goat's milk is more commonly used than that of the cow. Goats do very well where the country is rocky, and full of hills and mountains. In such a country there is not grass enough to keep cows. But the goats will

clamber about on the sides of the hills and mountains, and get a living on things that grow among the rocks.

The butter that you eat is a part of milk. I will tell you how they get it out of the milk. They let the milk stand in pans, and the creamy part of it rises. The butter is in this. They skim off the cream, and when they get enough of it they churn it. This makes the butter come, as they say. They mean that this gets the butter out of the cream. When the churning is done, you have the thick butter and the thin buttermilk. These were mixed together in the cream, but the churning has separated them.

Cheese can be made out of milk or cream. That which is made out of cream is richer than that which is made out of milk.

The butter, the cheese, and all the other things that you eat, help to make blood in you, just as milk does. How many things blood can be made out of! And then, too, how many things can be made out of blood!

What is milk made from? Does what the cow eats turn right into milk? What is it turned into first? How does the blood get to the bag? What is the milk factory? What two things about all this are so strange? What are the horns made from? What is strange about this? What other things in the cow are made from the blood? How did the calf grow to be a cow? Does a little calf have horns? How are the horns made? If you drink milk, what becomes of it? Can grass be turned into blood in you? Tell about the goats. What is butter? What part of the milk is butter in? What does churning do to the cream? Tell about cheese. What helps to make blood in you?

CHAPTER XI.

SWEET THINGS THAT WE EAT.

THERE is sugar in many things that we eat. Every thing that tastes sweet has some sugar in it. Sweet oranges and peaches have sugar in them. You know how sweet some grapes are. Raisins are dried grapes. When they become candied, it is because the sugar is separated from the juice of the raisins.

Before oranges become ripe they are very sour. But when they are ripe they are sweet. It is the same with other fruits, as peaches and grapes. There is no sugar in them, then, at first ; but after a while sugar is made in them.

There is sugar in many flowers. It is at the bottom of the flower. It is this sugary part of the flowers that the bees get. They make their honey out of it. We commonly say that bees gather honey. But this is not exactly so ; what they gather, they make into honey.

There is a great deal of sugar in some flowers. And the bees know where to find it. They are always in great numbers where there is much sugar. The flowers of the tulip tree have a great deal in the

bottom of them. This tree is very common at the South. The negroes are often as busy as the bees in getting the sugar from them. They climb the trees to pick the flowers, and then suck the sweet part of them.

There is a great deal of sugar in some plants. You know how sweet liquorice stick is. The liquorice ball is the dried juice of the plant. Sugar is sometimes obtained from a kind of beet, called the sugar-beet. In France there is much sugar made from this root. But most of the sugar that we eat, comes from the sugar-cane. The stalk of this plant is very much like a corn-stalk. It is larger and taller. The sugar is obtained from the juice. To get this juice, the stalks are cut up, and then are bruised between large iron rollers. This presses out the juice.

This juice is mostly water and sugar together. How do you think they separate them, and get the sugar by itself? First, they boil it down, as it is called. What good does this do? The heat drives off most of the water into the air, and a syrup is left in the boilers.

This syrup is drawn off into coolers. These are large shallow wooden trays. Here most of the rest of the water flies off into the air.

We now have sugar, but it is very damp. There is considerable water in it yet. It is now put into casks. These casks have holes in the bottom of them, and they are placed over tubs. There is a

draining from the casks into the tubs. When the draining is done, we have molasses in the tubs, and in the casks there is the common brown sugar that we use. Molasses is sugar and water together. You remember that I told you in Chapter IV, that the water is always ready to fly off into the air. If you leave molasses, then, standing in an open vessel for some time, the water will go off into the air, and there will be brown sugar left in the vessel. White sugar is made from brown sugar, but how this is done you are not old enough yet to understand.

The sugar-cane grows at the South. But there is much sugar made at the North. It is made from the juice of the sugar-maple. How strange it is that a hard tree should make sugar for us! But so it is. Very early in the spring, before the leaves are out, every sugar-maple goes to making sugar.

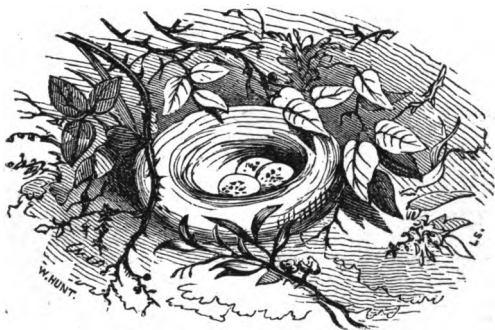
The sugar is in the sap. They get the sap in this way. Holes are bored in the trees, and the sap that leaks out is caught in vessels. Then the sugar is obtained from the sap by boiling, as is done with the juice of the sugar-cane.

There is, then, a great deal of sugar in every sugar-maple tree in the spring. Now suppose that a tree is not tapped at all. What becomes of all the sugar that is in it? Something must be done with it. It is used up in making leaves and bark and wood. How wonderful it is that sugar can be made into such things! We can not do it. But God has

made the tree in such a way that it can be done there. So when you look at the leaves of a sugar-maple, you can think of them as being made partly of sugar. But you can not taste any sugar in them. There is none there. It is turned into something else.

In what things that we eat is there sugar? What happens when raisins are candied? Tell about ripe and unripe fruits. Is there sugar in all flowers? Where in the flower is the sugar? Tell about the bees. Do they gather honey? Tell about the tulip tree. What makes liquorice stick sweet? What is liquorice ball? In what country is there much beet-sugar made? From what plant does most of our sugar come? What is it like? How is the juice got from the stalks? What is the juice? What does boiling it down do? Tell about the coolers. How are the sugar and molasses separated? What is molasses? What would happen if molasses were left some time in an open vessel? What tree makes sugar for us? Where in the tree is the sugar? How do they get the sap? How is the sugar obtained from it? If none of the sap is let out from a tree, what becomes of all the sugar? What may you think when you are looking at the leaves of a sugar-maple? Can you taste any sugar in them? Why not?

CHAPTER XII.



EGGS.

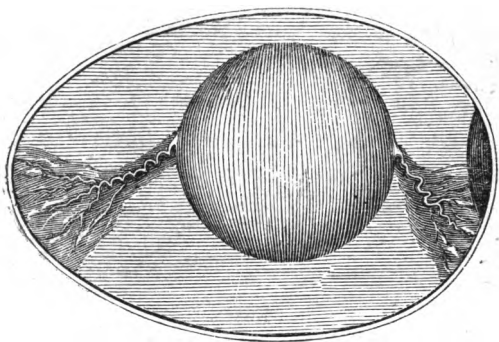
Look at a hen's egg. See how smooth and round it is! It is not exactly round. It is larger at one end than it is at the other. The shell is quite hard, and what is inside is shut up there very tight.

Let us see what is inside. There is the round yolk, as yellow as gold. All about this is the white of the egg, as we call it. Then there is a beautiful white skin all over the inside of the shell.

What do you think keeps the yolk from mixing up with the white? It is not because it is thick. It is as soft and as thin as the white is. Yet it keeps separate in a pretty round ball. Why does it keep so? It is because it is in a thin bag. If this bag

should be broken in any way, the yolk would run out and would not be in a round ball. Then if the egg should be well shaken, the yolk and the white would be mixed together.

This bag of yolk can not move about everywhere in the egg. It is fastened to the shell by two strings



as you see in this figure. The yolk is lighter than the white ; and so if it were not for the strings, it would go up in the white as a balloon goes up in the air. It would always be at the very topmost part of the egg. But it is held by these strings in such a way that it never rises high enough to touch the shell. They hold it down just as a balloon is held down by cords before they let it go up.

How strange it is that this yolk and white should turn into a chicken ! There is nothing in them that is like feathers, and bill, and feet, and spurs. But these and all other parts of the chicken are made out of them.

How is this done? Nothing can get inside to do it. That egg-shell is a very tight prison, and there is no door to it to let anything in. But in some way, after a while there is a chicken there. And when the chicken is made, the yolk and the white are all gone. So we know that it is made out of them. There was nothing else there for it to be made out of.

The chicken will not be made if you put the egg away in a basket. It must be left in the nest if you want it to be hatched. The chicken is made because the hen sits on the egg. But all that she does to it by sitting on it is to keep it warm.

Eggs can be hatched without having hens sit on them. Only keep them quite warm, and chickens will be made in them. Eggs have been hatched by steam. The steam kept them warm, just as the hen keeps them warm when she sits on them.

The chicken begins to be made in the yolk. A little heart is made there after the egg has been kept warm for two days. If the egg should be broken open just then, this heart would be seen beating away like the heart in you. There are little branches from this heart, and the blood goes all about in them. This blood is made out of the yolk and white. Then from this blood are made all the parts of a chicken.

You can cheat a hen by taking her eggs out of the nest, and putting in pieces of chalk, made into the shape of eggs. You would know that they are not eggs, but she does not, and so sits on them. And

she will sit on the eggs of ducks or geese, just as well as she does on her own.

It is funny to see how a hen acts that has hatched out a brood of ducks. The little ducks run off at once to the water. She follows them, and stands on the water's edge, cackling away at a great rate. She cannot swim herself, and she does not know that the ducks can. So she is very much alarmed, and tries by her cackling to call them away. But they will not mind, for it is grand sport for them to swim. The old hen gets quiet after a while, for she sees that no harm comes to the ducks. But she does not seem to understand how the little things that she has hatched, can swim about in the water, when she cannot. She thinks they are very strange chickens.

Is a hen's egg exactly round? What about the shell? What is inside? Is the yolk thicker than the white? Why does it keep separate from the white? What would happen if the bag of the yolk should be broken? Which is lightest, the yolk or the white? Tell about the strings? How is the yolk like a balloon? What are all the parts of a chicken made of? Is there anything in the yolk or the white that is like any of the chicken? Can anything get into the shell to make the chicken? How do we know that it is made out of the yolk and white? Why does the hen's sitting on eggs hatch them? Why is no chicken made if you put the egg away in a basket? How can eggs be hatched without having a hen sit on them? In what part of the egg does the chicken begin to be made? How soon is the heart made after the hen begins to sit? What is the use of the branches that go from the heart? What is the blood made from? What is made out of the blood? Tell about putting pieces of chalk in a hen's nest. And about her sitting on other eggs. Tell all about the hen and the ducks.

CHAPTER XIII.

MORE ABOUT EGGS.

I TOLD you in the last chapter how the chicken is made in the hen's egg. Now you will want to know how he gets out.

Some think that the hen breaks the egg and lets the chicken out. . A little boy told me that he thought this was the way. I asked him how the hen would know when the chicken was ready to come out. He said that she could hear him peep. But he can not peep so long as he is shut up in that round prison. He does not peep till he gets out. The first thing that the hen knows about it, is that a chicken is pushing out of the shell, and begins to peep.

The chicken can peep before he gets all his body out of the shell. He can peep as soon as he puts his bill out into the air. It is the air that he breathes in that makes him able to peep. You could not speak if you did not breathe. And so the chicken can not peep till he breathes. It is amusing to see a little head pushed out through a round hole in the shell, and to hear the chicken peep as he twists and turns and tugs away to get his body out.

Sometimes the chicken can not get out without help. Perhaps the shell sticks to him somewhere. Or, perhaps he tried to get out too soon. He was too much in a hurry, and did not wait till he was strong enough to get out. Chickens that try to make their way out of their shells before it is time, do not do well. They are very apt to die.

But I have not yet told you how the chicken gets out of his shell. I have said something about a round hole in the egg. But I have not told you how that hole is made. How do you think it is made? The chicken cuts it out. With what does he do it? With his bill, perhaps you will say. But that is not sharp enough to cut egg-shell. The bill does not cut it, but something on the end of the bill does it. It is a little sharp thing that is fastened on the chicken's upper bill. It is a tool that is given to him just to cut this round door in the shell, and it is never used for anything else.

When the chicken is ready to come out, he presses this cutting tool against the shell, and moves it around so as to make a round hole. But the door is not large enough to let the whole chicken out. He pushes his head out through it and peeps, and then he breaks the shell some as he tugs away to get his body out.

After he comes out, the little cutting tool is of no more use to him. It would only be in the way if it staid on. So it drops off in a day or two

I must tell you one thing more about the chicken's getting out of the egg. There is always a little air in the large end of the egg. This you see in the figure on page 44. Now when the chicken is all ready to come out, he puts his bill into this air, and draws it into his lungs, just as you draw air in when you take a full breath. This gives him strength to go to work to cut the egg-shell.

I have told you about hen's eggs because you see them so often. The eggs of other birds are very much the same inside. And little birds are made in them as chickens are made in hen's eggs. You have perhaps seen canary birds soon after they are hatched. Very little things are they, and but few feathers do they have at first.

The insects that we see everywhere in the summer, come from eggs. I could tell you a great many curious things about the laying and the hatching of their eggs. But I will mention only one or two of them.

The grasshopper lays its eggs in the ground. It has a thing like a two-edged sword, and it is in a sheath. Now when it wants to lay its eggs, it takes this sword out of its sheath, and makes a hole in the ground with it. It then drops its eggs down into this long hole. There the eggs stay through the winter, and in the spring the warm weather hatches them. Then up come the little grasshoppers out of these holes. Little bits of green things they are at

first. But as the baby grows to be a man, so they grow to be large grasshoppers.

The spider lays its eggs in this way. It spins its web so as to make a silken cup. Then it fills this cup full of eggs, and rounds them up well in a heap. This it does so carefully that there are almost as many eggs on top as there are in the cup. Then the spider spins its web all around the heaped up eggs. When it has done its work, the eggs are in a round, close bag. There they are safe from the cold of winter, and in the spring out crawl little spiders from all these eggs.

The fishes come from eggs. The little round things that you see in the spawn of a fish, are eggs. There are a great many of them. It would be hard to count them. And so a great multitude of fishes come from one fish.

How do some think that the chicken gets out of the shell? What did a little boy say about it? Can the chicken peep while in the shell? How soon can he peep? How is his peeping like your speaking? Why can not the chicken always get out of the shell himself? How is it with chickens that have to be helped out? What kind of a door does the chicken cut to get out? Does he cut it with his bill? Why not? What does he cut it with? Is the door large enough to let his body out? Is the chicken's shell-cutter used for anything else? What becomes of it after he gets out? Suppose it staid on,—what then? What is said about the eggs of other birds? Tell about the canary birds. What is said about insects? Tell how the grasshopper lays its eggs. Does it sit on them like a hen? What hatches them? Tell about the baby grasshoppers. Tell how the spider lays its eggs. When are they hatched? In what do we see the eggs of a fish? Does a fish have but few eggs?

CHAPTER XIV.

LIME.

WHEN a mason lays brick, he uses mortar to make the bricks stick together. You have seen them make mortar. They put lime into a large wide box, and pour water in with it. You know how it sputters and smokes. It is the water uniting with the lime that does this. They like each other so much that they make a great fuss about it. We sometimes see something like this in children. If two children that like each other very much, meet, what a hugging and kissing there is! They almost pull each other over. So it is with lime and water. They are so much in a hurry to get together, that they sputter and boil and hiss in doing it.

You do not see anything of this in things that do not like each other. Water and oil, you know, will not unite. They do not like each other at all, as we may say. So if you put them together in a vessel, they are very quiet. The water does not make a sputtering with the oil, as it does with lime. It just lets it alone. It will not have anything to do with it.

There is something else in mortar besides the lime

and water. There is sand in it. This helps to make the mortar hard when it becomes dry. Mortar, then, has three things in it,—lime, water, and sand.

Sometimes mortar has four things in it. This is when they use it for plastering walls in houses. Then they put hair in it. They commonly use the hair of cattle. The hairs lie every way in the mortar. The use of them is to hold the mortar together. It would be apt to fall off from the wall if the hair was not put into it. In plastering walls the mortar is not plastered on wide boards. It would not stick to them. Little strips of wood are nailed on before the mortar is put on. These are called laths. See of what use the lathing is. Some of the mortar gets in between the laths, and so it holds on. You could not hold on to the side of a house. But if there were slats there for your hands and feet, you could hold on. The laths serve for the plaster in the same way that these slats would for you.

A great many things are made partly of lime. There is lime in chalk. Chalk is lime united with something else. It is a kind of gas that it is united with. It is not the gas that we burn; it is another kind of gas. You breathe out some of this gas every moment from your lungs. And you can make chalk any time by breathing into lime water. I will tell you how this is. Lime water is water with some lime dissolved in it. It looks clear, as you see it in

a tumbler. But take a pipe-stem, or a straw, and blow into it a little while. It will become milky. Let it stand a short time, and there will be a little white powder in the bottom of the tumbler. This is chalk. It is what made the water look milky before it had time to settle. The lime has united with the gas that comes from your breath, and together they make chalk.

Of what use is the mortar between bricks? What happens when water is mixed with lime? How is this like children that love each other? Tell about water and oil. What is the use of sand in mortar? What three things are in mortar that is used in making brick walls? What four things are in plastering mortar? Why do they not plaster the mortar on to wide boards? What are laths? What is the use of them? Tell about the slats. Is there lime in many things? What is chalk? Is it the gas that we burn that is in chalk? Is there any of it in our breath? What is lime water? What will happen if you breathe into some? What is the powder that settles at the bottom? What is it made of?

CHAPTER XV.

MARBLE, EGG-SHELLS AND OYSTER-SHELLS.

MARBLE is made out of lime, and the same gas that is in chalk. You can hardly believe that the soft chalk is the same thing as hard marble. But so it is.

You will ask why it is that the marble is so much harder than chalk. It is because it is put together tighter than the chalk is. You know that some sugar is soft, and some is hard. The hard sugar is tighter together than the soft, just as marble is closer than chalk. In the rock-candy, as it is called, the sugar is very close together.

You will want to know how people get lime to make mortar and other things with. They get it by burning marble, or chalk, or oyster-shells, in a very hot fire.

Lime can be obtained from bones, too. There is a great deal of lime in the bones of animals. There is in your bones. How do you think it gets there? It is mixed up with different things that you eat, and so goes into the blood. And the bones, you know, are made from the blood, as well as everything else in your body.

The shells of eggs are made partly of lime. It is the lime that makes them hard. How does the lime get to the eggs? Hens and other birds eat the lime that is used in making their egg-shells, just as we eat the lime that helps to make our bones.

Sometimes, when hens are shut up, they do not have lime enough. Then their eggs have weak, thin shells. And hens have been known to lay eggs without any shells at all. This was when they had no lime at all to eat.

It is well to have a few oyster-shells in a hen-yard. "What good does this do?" you will say. "The hens surely will not go to work to eat such hard things as oyster-shells." I will tell you how it is. The shells get broken up, and some of the powder of the shells becomes mingled with the food that the hens pick up. In this way the lime gets into the blood of the hen, and then is used in making the shells of her eggs.

You know that a cuttle-fish bone is always hung up in the cage of a canary bird. Of what use is it? It is commonly said that it is of use to the bird in sharpening his bill. It may be of use to it in this way. But this is not its chief use. It is of the same use to the canary birds that the oyster-shells are to the hens. They get their lime that they eat, from it. Some of this lime goes into their bones. And some of it helps to make the shells of their eggs. As the birds peck away at their bone, some

of it goes into their mouths. And some of the dust and pieces of it become mixed up with the food they eat. In these ways, the lime of the bone gets into the blood of the birds, and so is used in making bones and egg-shells.

The shell of the oyster, which is his house, is made mostly of lime. Do you think his house is made before he is made? No, they are both made together. The shell is made from the blood of the oyster. Now how does the lime that is used in making the shell, get into the blood? Just as the lime used in making our bones gets into our blood. The oyster eats the lime with his food. It is in this way that it gets into his blood, and then is used in making his shell.

All other shells are made in the same way. They are made out of the lime that the animal in the shell eats with his food. In all the shells, the lime is mixed with a gas, just as it is in marble and chalk; and in our bones.

What is marble made of? How is it different from chalk? Why is it harder? Tell about sugar. How is lime obtained? How does lime get into our bones? What makes egg-shells hard? How does the lime get to the eggs? What happens if hens do not have enough lime? Of what use are oyster-shells in a hen-yard? Why do people hang a cuttle-fish bone in the cage of a canary bird? What is the chief use of it? What does the lime that the bird gets from it, help to make? Of what is the shell of the oyster mostly made? How does the oyster get its lime? What is said about other shells?

CHAPTER XVI.

PHOSPHORUS.

WHAT is it that makes a match take fire so quickly when you rub it on anything rough? I once asked some children this question. Some of them said sulphur, and some said brimstone. They did not know that sulphur and brimstone mean the same thing.

There is sulphur on the end of a match. But it is not this that makes it burn so quickly. For if you rub a roll of sulphur on anything, it will not set fire to it. There is something else, then, on the match, with the sulphur. If there was sulphur alone, it would burn very quickly if you should touch it to fire. But rubbing would not make it burn. It is what we call phosphorus, that the rubbing sets fire to. And as soon as this begins to burn, it sets fire to the sulphur that is mixed with it, and then the phosphorus and sulphur together set fire to the wood.

In making matches, they dip the ends of them into some phosphorus and sulphur melted together.

Now there is phosphorus in your blood? What

do you think it is there for? It is wanted to make your brain and your bones. There is only a little in your brain, but what is there is wanted. The brain could not do without it. There is a great deal of it in your bones. There is enough to make a great many matches. There is a plenty of phosphorus in the bones of other animals as well as in ours.

I asked some children once, why the phosphorus in our bones did not take fire. A bright little boy said, that it was because they were all covered up, and we did not rub them against anything. But this can not be all the reason. A dry bone has all its phosphorus in it, but you know that you can not set fire to it if you rub it against anything ever so hard.

If the phosphorus were alone in the dry bone, it would burn when you rub it. It would, too, if there was sulphur with it. Then the bone would be like matches, and we should not need to have any matches made. We could use bits of the dried bones of animals for matches.

The real reason that the phosphorus in dry bones will not burn when we rub them, is this. It is united with some things that will not let it burn. It is united with lime and some other things.

If a bone is broken, how do you think that it is mended? "Why, the doctor sets it," you will say. But the doctor can not get in to the ends of the bone to

mend them. He does not fasten them together with rivets, or anything else. All that he can do is this. He can put the ends of the bone together right, and then fasten things around the limb to keep them so.

Something else must be done to mend the bone. How is it mended? "The two ends grow together," you will say, "that is all." But how do they grow together? I will tell you. To make them join together, there must be brought to them some phosphorus and lime. With these some more bone is made between and around the two ends of the broken bone. In this way they are fastened together. It takes several weeks to do this.

Now how do you think that the phosphorus and lime get to the two ends of the bone? We eat them, and they are brought there in the blood.

The phosphorus that people use in making matches, they get from the bones of animals. How they separate it from the lime and other things in the bones, you are not old enough yet to understand.

What did some children say made matches burn when rubbed? How do you know that it is not sulphur that does it? What takes fire first in a match? What next? And what next? How are matches made? Why is there phosphorus in your blood? Is there much of it in the brain? In what is there a great deal? What reason did a boy give why our bones do not take fire? How do you know that he did not give the right reason? What if there was nothing but phosphorus in bones? What if there was sulphur with phosphorus in them? Why is it that the phosphorus in a bone will not burn when you rub it? Can a doctor mend a broken bone? What can he do? What is the bone mended with? How do the phosphorus and lime get to the bone? How do people obtain phosphorus?

CHAPTER XVII.

SULPHUR AND SALT.

THERE is sulphur in our blood, as well as phosphorus. There is salt, too, in the blood. The salt that we eat with our food goes into the blood. We eat it with our food because it makes it taste good. But this is not all the use of it. It is wanted in the blood. We could not do without it.

Salt is good for animals. The farmer gives salt to his sheep and cattle. When hay is put into the barn, salt is thrown all over it. This helps to keep the hay sweet ; and, besides, it is good for the cattle to have their food salted, just as it is good for us. The salt is needed in their blood.

The phosphorus and sulphur we do not eat in the same way that we do salt. We do not take them and sprinkle them over our food. They would not taste good if we should eat them in this way. But we do really eat them. They are in many things that we eat. But they are mixed up with them in such a way, that we should never know by the taste that we are eating sulphur and phosphorus.

Every time that you eat peas, you eat sulphur ;

for there is sulphur in them. When you eat an egg, you eat both phosphorus and sulphur. You know that the silver spoon that you eat it with turns black. It is the sulphur in the egg that does this. It unites with some of the silver. This black part is not sulphur. If it was it would be yellow. It is not silver. If it was it would be white and shining. It is sulphur and silver together, and this is black. When you rub off this black part, you lose some of your silver spoon. You lose the silver that has united with the sulphur.

I was telling about this to some children once, and one of them asked me why his knife turned black when he pared an apple with it. I told him that there was an acid in the apple, and that this acid united with some of the steel of his knife. Then a little girl asked me why her *silver* knife was not blacked when she pared an apple with it. I told her that the acid in the apple did not like the silver as well as it did the steel. It likes the steel so well, that it takes right hold of it, and they are joined together in one very quick. And when you rub this black part off, you lose some of your knife-blade. You lose what is united with the acid of the apple.

I have told you how the salt and phosphorus and sulphur that we eat, go into the blood. Now we eat a great deal of sugar; and yet there is no sugar in the blood. Where is it? It can not be found any-

where in the body. What is the reason? The sugar is not lost. It is turned into something else.

You remember that I told you in Chapter XI, that much of the sugar in the sugar-maple is used in making leaves and other things in the tree. So too, much of the sugar that you eat is used in making different parts of the body. It is in this way that sugar helps to make you grow. Some people seem to think that the only use of sugar is to please our taste. But this, you see, is not so. It is of the same use with other things that we eat. It nourishes us.

What is there in the blood besides phosphorus? In what two ways is salt useful? What is said about giving salt to animals? What about salting hay? Do we eat phosphorus and sulphur as we do salt? How do we eat them? What is in peas? What in eggs? Why does a silver spoon turn black when you use it in eating eggs? What is this black part of the spoon? What happens when you rub this off? Why does apple juice turn a knife-blade black? Why will it not do the same to a silver knife? Does the sugar that we eat go into the blood? What becomes of it? Tell about the sugar in the sugar-maple. How does sugar do like this in us? In what two ways is the sugar useful to us?

CHAPTER XVIII.

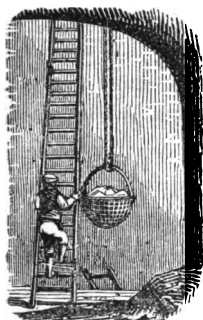
METALS, MINES AND MONEY.

THE chief metals are iron, copper, tin, zinc, lead, gold, silver and quicksilver. I will tell you some things about them.

The metals are found in the earth, mixed up with other things. Men dig for them. The places where they get them are called mines. The coal that we burn, is obtained from mines, but not from the same mines where they get metals.

Often they dig very deep into the earth in mines. Sometimes they dig straight down. But sometimes they dig into the side of hills. Then they often make long passages in under ground. I once went into a lead mine where there was a very long passage. Some of the way we went in a boat. It was entirely dark, and so we had to carry torches to light the way. Where they are working in a mine under ground, with all the light shut out, they have lanterns hung up to work by. Sometimes the workmen have lamps fastened upon their heads. They look very strangely, as you see them going about here and there.

Here is a picture of a man going up a ladder in a mine that is dug down into the earth. You see the top of another ladder by which he has come up from some spot below. It is a tin mine, and they are drawing up, you see, a large basket filled with pieces of the tin ore.



Different metals are used for different things.

Money, you know, is made of gold, or silver, or copper. Pieces of money are called coins. Gold coins are not all gold. If they were they would wear out soon, for gold is rather soft. It is almost as soft as lead. A stick of gold can be bent double. A little silver and copper are mixed with it, to make it hard enough for use.

Perhaps you will want to know what paper money is. If you read what is on a bank bill, you will see that it is a promise to pay some money. It is a promise to pay some gold or silver. The paper is good for nothing without this promise on it. It is good for nothing, too, if the bank can not pay as it promises. A bill is good when you can take it to the bank, and get in gold or silver just what it promises to pay.

A dollar bill, then, means a dollar's worth of gold or silver. A ten dollar bill means ten dollar's worth. But, you will ask, why not use the gold and silver,

and have nothing to do with bills? This does very well if we want to use but little money at a time. But a hundred dollars of gold would be heavy in the pocket. And so much silver would be very heavy indeed. But a hundred dollar bill is a very little thing, and takes up but little room.

Iron would not be good to use for money, because it would take a great deal of it to make a dollar's worth. The old-fashioned copper cent, you know, is not convenient. But an iron cent would have to be much larger, for copper is worth much more than iron. But though iron is not good to use for money, it is useful for a great many things. I will tell you about this in another chapter.

Every metal is good for something. Some are good for one thing, and some for another. In the next chapters, I am going to tell you what the different metals are good for.

What are the chief metals? What are mines? Where is coal obtained? Are mines always dug in the same way? Tell about the lead mine. Tell about the tin mine. What are coins? What metals are used in making money? How soft is gold? Why are silver and copper mixed with it? What is on a bank bill? When is a bill a good one? Why do we use bills instead of gold and silver? Why would not iron do to use for money? What is said about the metals being good for different things?

CHAPTER XIX.

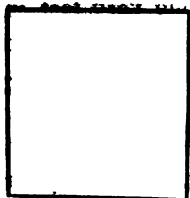
GOLD, SILVER AND QUICKSILVER.

GOLD is used for making many nice articles, such as watches, breast pins, rings, pencil cases, bracelets. Some very wealthy persons have spoons, pitchers, and even tea-sets of gold. Gold is the chief thing in the crowns of kings and queens.

In all these things the gold is polished very much. This means that it is made very smooth indeed, and so is very bright. And it does not become dull. Vanes on steeples are often gilt. That is, they are covered over with a little gold. This will keep bright year after year. It glistens in the sun as brightly as ever, after it has been up there many years. The wind, and rain and snow, will, after a while, wear it off, and then the vane must be gilt again.

Did you ever see gold-leaf? How thin it is! It is so thin that you can blow it about in the air like a feather. It is thinner than the finest paper. How do you think that they make it? It is done by hammering. But they do not strike the hammer right down upon the gold. They put it between pieces of skin, and then hammer it. A bit of gold of the

size of the head of a pin, can be beaten out so as to spread over fifty square inches. This would be fifty times as large as this figure, or almost twice as large as this leaf.



Silver is almost as beautiful as gold. How white and shining it is when it is polished ! There is more of silver in the world than there is of gold. So we make more things out of it. We make out of it, spoons, and pitchers, and bowls, and cups, and tea-pots, and a great many other things.

Silver does not keep bright like gold. All silver things have to be rubbed with something once in a while, because the air makes them dull.

Silver is not as soft as gold is, but it is too soft to use it alone. All the silver coins have some copper with the silver. This is to make them hard, so that they will not wear out easily. The silver that spoons and other things are made of, has copper with it for the same reason. There is only a little copper with it. If any one should try to cheat, and put in too much copper, the silver would not look white enough.

German silver, as it is called, is not silver at all. There is really no silver in it. It is made of copper mixed with two white metals, zinc and nickel. I will tell you about zinc in the next chapter.

Quicksilver is a very curious metal. It is what you see in thermometers. It will run like water.

If you put a little of it in your hand, and pour it out on a smooth table, it will run along very fast in little balls like shot. It is because it moves so quickly, that it is called quicksilver. It is sometimes called mercury.

It is used in a great many ways. I will tell you what its use is in the thermometer. Hold your warm finger on the little round ball at the bottom, that they call the bulb. You will see the quicksilver go up the tube. Why is this? It is because the heat swells the quicksilver, and so it wants more room. The only way that it can get the room is to go up in the tube. You remember how I told you in Chapter VI, that the cold pinches the quicksilver. Now in a very cold morning the quicksilver is so pinched, or shrunk up, that it is almost all of it down in the bulb. But bring the thermometer into the warm air of the house, and the quicksilver will swell so as to run quite high up in the tube.

Quicksilver is used in making looking-glasses. It is put on the back side of the glass. But it is not quicksilver alone. It is united with some tin. This makes a different thing of it. The quicksilver alone would not stick to the glass. But unite it with tin, and then it will stick.

Quicksilver unites with other things besides tin. It unites with sulphur. And then it makes one of our most beautiful red paints, called vermilion. How strange this is! Quicksilver is white, and sulphur

is yellow. But unite them together, and they make a substance which is of a bright red color.

Quicksilver, united with a certain gas, makes the white powder that we call calomel.

What articles are made of gold? What do some very rich persons sometimes have made of it? What is it the chief thing in? What do we mean when we say gold is polished? What when we say a thing is gilt? Tell about the vanes. How thin is gold-leaf? How is it made? How much leaf can be made of a piece of gold as small as a pin's head? How does silver look? Why are more things made out of silver than out of gold? What are some of the things made out of it? What do they mix with silver? Why is this done? What if too much copper should be mixed with silver? What is German silver? What kind of a metal is quicksilver? Why does it have this name? Tell all about its use in the thermometer. What is it mixed with when it is put on the back of a looking-glass? Why not put it on alone? What does quicksilver make united with sulphur? What is calomel made of?

CHAPTER XX.

ZINC, COPPER, TIN AND LEAD.

ZINC is a bluish-white metal. It becomes dull very easy. We see it in large sheets. It is put into this shape to be used in various ways. It is placed under stoves to guard the floor. Refrigerators are lined with it. So are sinks, sometimes. It is sometimes used in covering roofs, to keep the rain out.

Copper is a reddish-brown metal. It is quite hard, and so, as I have told you before, it is mixed with silver and gold to make them hard enough for use. Copper is used in making many different kinds of vessels. Kettles and boilers for heating water are often made from it. It is used in covering the bottoms of ships. It makes a good covering because it is hard, and can not be broken easily. Another reason is, that it is smooth, and so lets the ship glide along easily in the water.

Though copper is red, united with a certain acid, it makes a beautiful blue substance, called blue vitriol. You can try a pretty experiment with this. Dissolve some of it in a little water. Then hold your knife-blade in it a few minutes. When you take it out it

will be covered all over with copper. It will have a red coat on. Why is this? It is because the acid loves the steel better than it does the copper. It leaves the copper to join the steel, and the copper that it leaves settles upon the knife. The acid that has left the copper, is inside of the red coat of the copper, and is joined with the steel.

What is brass? Is it a metal? It looks like one. But it is not. It is two metals united together. The reddish copper and the bluish-white zinc, united make the yellow brass.

Bells are made of some metals melted together. Copper is the principal metal in large bells.

Tin is a very useful metal. What we commonly call tin is not tin alone. The sheets of tin, of which pans and other things are made, are really sheets of iron covered with tin. The sheets are dipped in melted tin, and the tin unites with the iron.

Pewter is made of tin mixed with a little lead. It is not much used now. When I was a boy, pewter dishes and plates were much used. I remember how bright the pewter plates and platters looked, ranged along, standing upon edge, on the shelves in the kitchen. It was a bad sign to see them look dull. It showed that there was laziness there. The reason that pewter is used so little now is, that crockery is so much cheaper than it used to be.

Lead is a metal that is used in many ways. Bullets and shot are made of it. Water pipes are often

made of lead. Cisterns are lined with it. Types are made mostly of lead.

When I was a boy, every boy and girl had a plummet, as it was called. This was a little piece of lead. Some would have it a plain piece, and some would pare the lead with a knife so as to have it shaped like something. It was very common to shape it like a hatchet. The plummet was always tied by a long string to one end of a ruler, and we used it to rule lines in our writing books. There is no need, now, of ruler and plummet, for the lines are all ruled for you in your writing books.

Sugar of lead, as it is called, is a white powder. It is not lead alone. It is lead united with vinegar. How strange that the sour vinegar should make lead have a sweet taste when it unites with it. Sugar of lead is used as a medicine.

What is called white lead is a white powder that is used in making white paint. It is lead united with a gas.

What is the color of zinc? Does it keep bright? In what shape do we see it commonly? In what different ways is it used? What is the color of copper? Is it soft or hard? What things are made of copper? Why is it a good covering for the bottoms of ships? What is blue vitriol? Tell about the experiment with it. What is brass? What is bell metal? What are tin sheets? What is pewter? Tell about the pewter plates. Tell some things that lead is used for. Tell about the plummet and ruler. What is sugar of lead? What is there strange about this? What is white lead?

CHAPTER XXI.

IRON.

I HAVE not told you yet about the best of all the metals. It is iron. "What!" you will say, "is iron better than gold or silver?" Yes; because it can be used in so many ways.

Just think over the things that can be made out of iron. I will mention some of them, and you can think of others and tell your teacher. Nails, screws, hinges, door-latches, keys, locks, shovels, tongs, pokers, stoves, stove-pipes, wire, chains, kettles, horse-shoes, the rails on rail-roads, wheels, hooks, guns, swords, needles, knives, forks, scythes, saws, spades, hoes, plows, trowels, axes, and so on. Hoops for barrels are made of iron, when the barrels need to be very tight and strong. What we call tin is, as I told you in the last chapter, iron with tin on the outside. Pillars in churches and other buildings are often iron. The fronts of some buildings are made entirely of iron. Bedsteads and even chairs are sometimes made of this metal. The spring of a watch is iron made into steel.

Here are a great many things made of iron. But

I have mentioned only a part of the things that are made of it.

Now because iron can be used for so many things, God has given us a great deal of it. There is more iron in the world than there is of all the other metals together.

There is no other metal that would do in place of iron. Gold would not. You could not cut with it. It would make poor nails. Golden nails would bend so easily, that you could not drive them into hard wood. You could not shovel with a gold shovel. It would bend whenever you hit anything hard, or raised anything heavy.

Silver would not do. We sometimes cut apples with a silver knife. But we could not cut a stick or mend a pen with it. And most of the things that we do with iron, we could not do with silver. Like gold, it is not hard enough or strong enough to take the place of iron.

Copper would answer better than gold or silver in place of iron. But it would not be near as good as iron for many things. Copper nails are quite strong, but not as strong as iron nails. A copper knife or axe would not do well at all.

Such things as stoves, kettles, and other vessels, are made of *cast* iron, as it is called. They are made in this way. The iron is melted in a furnace. When it is melted it will run as easily as molasses. They let it run out into large kettles, and pour it

from these into the moulds. As they pour it out, it looks like running fire. After a while, they open the moulds, and take out the things which they have cast in them.

Wrought iron is different from cast iron. It is made wrought iron by heating and hammering it. It is not brittle, as cast iron is. Horse-shoes are made of wrought iron. If they were made of cast iron, they would crack as the horse strikes them on the stones. A poker is made of wrought iron. If it were cast, it would snap off as you work it in the grate.

You have perhaps seen the blacksmith join one piece of iron to another, by hammering them together when they are red hot. This is called welding. He could not hammer them together when they are cold. It is like joining two pieces of sealing wax together. They will not unite unless they are heated so as to be quite soft. You only have to press the pieces of sealing wax together, but the iron must be hammered, because it is not as soft as the wax when it is heated.

Wrought iron can be made into sheets by hammering. But this can not be done with cast iron. If that should be hammered it would break in pieces.

Iron wire is made from wrought iron. It is made by drawing it through holes in steel. They draw a rod through a hole that is a little smaller than the rod is. Then they draw it through one a little

smaller than the first hole, and another a little smaller, and so on till they make the wire small enough. Wire is made from gold, and silver, and copper, in the same way. It can be made much smaller than they can make iron wire.

What is the best of all the metals? Why is it the best? Mention some of the things that are made of iron. What is said about there being so much iron in the world? Why would not gold do in the place of iron? Why would not silver? How is it with copper? What things are made out of cast iron? How are they made? How is wrought iron made? How is it different from cast iron? Why would it not do to have horse-shoes made of cast iron? Why is a poker made of wrought iron? Tell about welding. How is this like joining two pieces of sealing wax together? Why must the iron be *hammered* together? Of what do they make sheet iron? Can you make sheets of cast iron? Why not? Tell how iron wire is made. What is said about wire made from some other metals?

CHAPTER XXII

MORE ABOUT IRON.

IRON is made into steel by heating it for a long time in charcoal. Steel is very much harder than common iron. So it can be made very sharp. Penknives and razors, and other sharp things, are made of steel. The steel of which they are made is very brittle. You can bend the blade of a pen knife but evry little without breaking it.

But some steel can be bent very much. Sword blades can often be bent double. A watch-spring, too, can be bent much more than this. It can be rolled up together. The difference between this kind of steel and the steel of penknives and razors, is made in this way. If steel is heated and then cooled quickly by plunging it into cold water, it is brittle. If it is cooled slowly, it is not brittle, but can be bent. It is flexible, as we say.

Iron unites with many other things. Iron rust is iron united with something from air and water. Iron is very often found united with sulphur. Then it has commonly a golden yellow color, and it has often been supposed to be real gold. Some of it has

been brought to me several times by farmers, who thought that perhaps they had a gold mine on their farms. They were very much surprised when I told them that it was nothing but iron and sulphur together.

Iron joined with other things has different colors. Rust, you know, is reddish-brown. Iron with sulphur is sometimes a golden yellow, and sometimes a silvery white. Green vitriol is iron united with a certain acid. This acid is the same that makes blue vitriol when it is united with copper. It is the acid which they call oil of vitriol.

Iron joined with some things dissolves in water or spirit. Iron is often given as medicine in wine. It is not iron alone, but iron joined with something else. If it was iron alone, it would not dissolve in the wine. You have heard of springs where the water has iron in it. In these the iron is united with something.

There is iron in our blood. It is the iron that helps to give the blood a red color. There is but little of it in the blood, but what is there is wanted. We could not do without it. When you see any one that is very pale, you may know that he has not iron enough in his blood. And when you see one that has a fresh, healthy, ruddy cheek, you may know that there is a plenty of iron in him.

You will ask how the iron gets into your blood. You eat it. But how? You do not bite off a

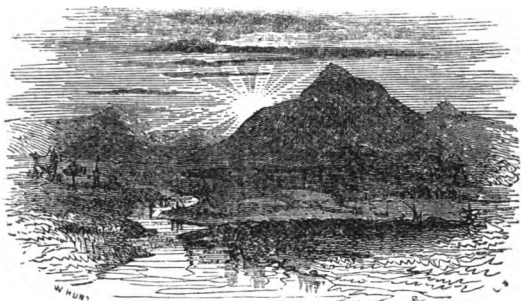
piece as you do candy. And you do not sprinkle iron dust over your food as you do salt. But the iron is mixed up very finely with some of your food. It is so fine that you can not see it.

Every time that you drink milk, you drink iron. White as the milk is, there is iron in it. If there were not, the baby, that lives on milk alone, could not have any iron go into his blood. And so he would grow pale and thin. He would after a while die, if he could not have some iron go into his blood.

I have told you about many different things that are in the blood,—salt, lime, phosphorus, sulphur and iron. But there are a great many other things besides these in the blood. They are all wanted, because everything in the body is made out of the blood.

How is iron made into steel? How is steel different from common iron? What are made out of steel? Why can not you bend the blade of a penknife without breaking it? What steel things can be bent very much? How is the difference made between this steel and that steel which is brittle? What is iron rust? Tell about iron's uniting with sulphur. What mistake is often made about this? Tell about the different colors of iron, united with different things. What is green vitriol? How is this like blue vitriol? Will iron, if alone, dissolve in water or spirit? How is it when the iron is united with something else? What does the iron in our blood do? Tell about pale cheeks and red cheeks. How does iron get into your blood? How do you eat it? Tell about the iron in milk. If there were no iron in milk, what would happen to a baby, living on milk alone? Mention the different things that I have told you are in the blood. Why are there many other things besides these in the blood?

CHAPTER XXIII.



SUN, EARTH, MOON AND STARS.

THE sun is a very large round ball. It does not look very large to us, because it is a great way off. It is just so with other things. If you look at a man when he is up on anything very high, he seems to be very small. If he is up on a very high steeple, he looks like a very little boy. Did you ever see a balloon go up? Before it starts it looks very large. But as it goes up it looks smaller and smaller. When it gets up very high, it is very small indeed. It is a mere speck. Now if the sun were near to us, it would be very large indeed, but as it is a long way off, it looks quite small.

In the picture above, the mountain looks a great deal larger than the sun does. It is because it is so

much nearer than the sun is. It would take a great multitude of such mountains put together, to make a ball as large as the sun.

How far off do you think the sun is? How long do you think it would take you to go there, if you should travel very fast? A boy said that he thought it would take a year. It would take a great deal more than that. It would take more than five hundred years, if you should travel night and day as fast as we go in a railroad car. A great way off, then, the sun must be. The light and heat that come to us from the sun, have a long way to come.

The stars look very much smaller than the sun. This is not because they really are all of them so much smaller. Some of them are larger than the sun. The reason that they look so small, is, that they are so far off. Some of them are so far off that we can not see them without a telescope.

I suppose that you have often looked up at the milky way, as it is called, in a clear night. This is made up of stars that are a very great way off. They are so far off that you can not see each star alone by itself. They are a shining company, all mixed up together. You know that sometimes you look at a crowd of people, who are so far off, that you can not see each person by himself. So it is with this crowd of stars. Many of these stars in the milky way, are larger than our sun. They are really other suns.

The moon seems to be almost as large as the sun. But it is a great deal smaller. It would take many millions of moons to make a ball as large as the sun is. The reason that it seems to be nearly as large as the sun is, that it is so much nearer to us than the sun.

The stars are round balls, just as the sun is. The earth that we live on is a round ball, too. It does not seem so to us, because it is so large. We can see but little of it at a time. Look at a very little insect, walking along on a huge ball, or globe. It can see but a little way, and so does not know that it is on a round thing. It is the same way with us on this round earth. Even if we go up a very high mountain, we can see but a small part of the whole earth. It does not seem round to us any more than the big ball does to the little insect.

The earth keeps going round the sun. It takes a year for it to go clear round. It keeps turning over, too, just as a ball turns over as it rolls on the floor. It turns over once every day.

It seems to us as if the earth was flat, and stood still all the while. And the sun seems to rise and set. But it is not so. It is the sun that keeps still. All the moving is done by the earth.

This is very strange, you will say. But think a moment, and you will see that it is not so strange. Many things seem to move when they do not. When you are sitting in the cars in a depot, and another

train is going by, it often seems that the train which you are in moves. So, too, when you are riding swiftly in the cars, it seems as if the fences and houses and trees were flying by. And so it seems as if the sun was moving, when it is really the earth that moves.

A man that owned a mill-pond once said, that he did not believe that the earth was round and kept turning over. "If it was so," said he, "my mill-pond would have been spilt out long ago." He thought that it would be like turning a dipper over when it is full of water. Why the water in the ponds and seas and rivers, is not spilt out as the earth whirls round and round, you can understand better when you are a little older.

What is the sun? Why does it not look very large? How is it with a man on a high steeple? Tell about the balloon. Tell about the mountain and the sun. What did a boy say about traveling to the sun? How long would it take to go there? Are the stars small? Why do they look small? How large are some of them? What is the milky way? Why can not you see the stars in it? What is this like? Tell what is said about the sun and the moon. What is the shape of the stars? Why does the earth seem to us not to be round? Tell about the insect on a globe? How long does it take the earth to go round the sun? In what other way does the earth move besides this? Does the sun really rise and set? What makes it seem to do so? Can you always tell whether you are moving along in the cars? Tell how the houses and fences and trees seem to move when they do not. Tell what the man said about his mill-pond.

CHAPTER XXIV.

LIGHT.

Most of our light comes from the sun. In a very cloudy day we are apt to say that the sun does not shine. This is not exactly so. It shines just as much as ever, and it shines some on us. It does not shine upon us as much as when there are no clouds. The clouds keep a part of the light from coming to us. It is as a curtain at a window keeps a part of the light from coming into a room. A thick curtain keeps out a great deal of light. So when the clouds are very thick, but little light comes through. The thin, light clouds that you sometimes see, are like the gauze curtains that keep out but little light.

When it is night to us, the sun is not shining on our part of the earth. We are turned away from the sun when it is dark, and it is shining on some other parts of the earth. It is day, then, to some of the earth, while it is night where we are. And when it is day to us, it is night to some other people on the earth. It is night to those who are on the other side. All this the teacher can make plain to you with any round thing, and a candle or lamp.

When it is night, it is not all darkness. There is always some light. We have the light of the stars, and some of the time the light of the moon. The light of the moon, and of some of the stars, comes really from the sun. They do not make the light. The light is made in the sun. Then it goes to the moon and stars, and part of it bounds off from them and comes to us. There are many of the stars that make light. They are really suns. They look small because they are a great deal further from us than the sun is.

You can see how light bounds off, in a great many things. You can see it when the sun shines on a looking-glass. The light bounds off, and if it comes to your eyes it dazzles you. You can see the light of the fire bounding off from bright brass andirons. Now just in the same way the light of the sun bounds off from the moon and stars, and comes to our eyes.

The light of the sun has a long way to travel to come to us. It takes eight minutes for it to come from the sun. But light, you know, goes very fast ; as quick as a flash, as we say. A long journey must it go, then, in eight minutes.

Besides the light of the moon and stars, we have in the night the light of things that we burn. We burn candles, and oil and burning fluid in lamps, and gas from the gas-pipes. When people have none of these, they sometimes burn pine knots for light.

Now any flame that you see is really burning gas.

In the candle, the heat melts the tallow and makes it go up the wick, and then turns it into gas. This burns and gives the light. So the oil or the burning fluid in the lamp, as it goes up the wick, becomes gas and burns. The flame of wood or coal is burning gas.

The gas that we burn from our gas-burners, is made in a gas-factory, sometimes from coal and sometimes from oil. Then it comes from there in pipes to our houses, just as the water comes to us in aqueduct pipes. It is not burnt where it is made. But when we make gas in a candle, the gas is burned where it is made, and as fast as it is made. Every time that you light a candle, or a lamp, or a fire, you set a gas-factory to work ; but the gas that is made is all burned up at the factory. In this it is different from the making of gas that comes to us in pipes from the gas-works.

From where does most of our light come? What is said about the sun in a cloudy day? Tell how clouds are like curtains? When it is night, why is it dark? Is it night all over the earth at the same time? When it is day to us, to what people is it night? What do we have some light from at night? Do the moon and all the stars make light? Tell about the light's bounding off from the sun. What are some of the stars? Why do they look so small? What do we often see light bounding off from, as it bounds off from the moon and stars? Does light move quick? How long is it in coming from the sun to us? Tell about the light from burning things. What is the flame of anything? How is gas made in a candle? What is the gas that we burn from burners made from? How does it come from the gas works to us? How is making gas to go in pipes, different from making gas with a candle, or a lamp, or a fire?

CHAPTER XXV.

BEAUTIFUL THINGS.

THERE are a great many beautiful things in this world that we live in. Some of them are large, and some of them are small. Look at the clouds in the morning, when the sun-light paints on them such bright colors. They are very large. The rainbow, too, is large. But some of the flowers that are so pretty, are very small indeed. And I will tell you in another part of this chapter, about some beautiful things that are so little, that you can not see their beauty without a microscope.

Why did God make so many beautiful things? One reason is, that he wanted to please himself. He likes beautiful things. Another reason is, that he wanted to please us. He loves us, and likes to make us happy. And so he gives us things that we like to look at.

There are some things that are made only to please the eyes. The flowers are made for this. They are not good to eat as the fruits are. We look at them and admire them. We love them because they are so pretty.

Fruits are made for us to eat. But many of them are very beautiful. How much we admire the color of oranges and lemons, and some kinds of peaches and apples! Grapes are very beautiful, as they hang in their rich clusters. God likes to give us beauty in all things, and so the fruits, besides tasting good, are pleasant to the eye.

How pleasant to our eyes is the green grass! It makes a carpet for the earth, that we like to look upon. And the green trees and bushes are beautiful, too. Do you know what a desert is? It is where you can go a long way without seeing any grass, or bushes, or trees. It is all sand, sand, sand. When a traveler has crossed a desert, how beautiful to him are the first grass and leaves that he sees!

Did you ever hold a leaf up to the light to see how pretty it is? If you have not, do it to the first leaf that you get. Look at a good many leaves in this way, and you will see that the beauty is not all in the flowers. There is much in the leaves, too.

The colors in some shells are very pretty. Now shells, as I told you in Chapter XV, are houses that some animals live in. The beautiful colors of the shell are of no use to the animal that lives in it. He has no eyes to see them with. Of what use are they, then? They are made for our eyes to see, after the animals in the shells are dead. It was to please us that these colors are put there.

There is a great deal of beauty in birds. The

colors of some of them are splendid. In all of them the feathers are very pretty. Did you ever look at a feather carefully, and see how nicely and prettily it is made?

What do you think is the most beautiful of all the things that God has made? Some of you will say one thing, and some another. I think that the most beautiful thing is the eye of a little child, when there is a sweet smile on its face. You can see that it is very beautifully made, as you look straight into it when there is no smile. But when a smile lights it up, a new beauty seems to shine from it.

I have told you only about a few of the many beautiful things in the world. I have told you, too, only about things that you can see with your eyes alone, without any help. But when you help your eyes with a microscope, you can see a great deal more of beauty than you can without it. A butterfly's wing is very pretty. But you can not see how very beautiful it is without looking at it through the microscope. This will show you that it is covered all over with beautiful scales. Above is a picture of one as it looks when we see it through a microscope.



It is so small that you can not see it at all with your eye alone. In some butterflies these scales are put on like shingles on a roof. They are in regular rows, and each row laps over the next row.

You know that when you take hold of a miller's



wing, there is a little silvery dust that sticks to your fingers. What

do you think this dust is? It is a great many pretty scales. Here is one of them, as we see it through the microscope.

What is said about the world that we live in? What are some of the beautiful things that are large? What are some that are small? What is one reason why God made so many beautiful things? What is another reason? What are flowers made for? Tell about fruits. What is said about grass? And about trees and bushes? What is a desert? What is said about leaves? Why are the colors of a shell of no use to the animal that lives in it? Of what use are they? Tell about the beauty of birds. What is the most beautiful thing that you have ever seen? What is said about the eye of a child? Are there only a few beautiful things in the world? How can you see the most beauty, with your eye alone, or with the microscope? Tell about butterflies' wings. What is the dust of a miller's wing?

CHAPTER XXVI.

WHAT WE WEAR.

How many different things make up the clothing that we wear! Did you ever think where all these things come from? I will tell about this.

There is cotton, that grows in the pod of a plant. There is linen, that comes from the bark of another plant. Anything woolen that we wear, came from the back of the sheep. All silk things are made from threads spun by worms. This I will tell you about in the next chapter. The furs that we wear once kept some animals warm in some very cold country. The buttons on our clothes are made from different things. If they are iron, they came from some mine. If they are horn, they are from the horns of some animal. If they are ivory, they came from the tusk of the elephant. If they are glass, they are made of sand and some other things, put together and melted into one in a very hot fire. Our shoes are made of the skin of some animal. If there are pegs in their soles, these came from some tree. If there are nails in the heels, these came from some mine. Our India rubbers are made from a gum that

comes from a tree. The pieces of whalebone, so much used in dress now, came from the big whales in the sea. Our pins, and gold and silver ornaments, came from mines. Our winter hats are made from wool, and our summer hats from different kinds of grass.

I will tell you something more about some of these things.

All our cotton cloth is made from what grows in the pods of a plant. You have seen the pod of a thistle in the fall. How silvery white is the down in it! Now this is very much like the pod of the cotton plant. It is from such down that they spin the thread with which cotton cloth is made. In the cotton pod the down is packed in together. What we call cotton wool is this down all picked apart.

Linen cloth is made from what is got from the bark of a plant called flax. It is the fine part of this bark that is used in making nice linen. The coarse part is what we call tow.

The bark of another plant is used for making strings, and cords, and ropes. It is hemp. This grows much higher than the flax. It is taller than a man. A field of it looks very beautifully as the wind blows over it.

All our woollen clothes are made of the wool that grows on sheep. The sheep are sheared every once in a while, and so the wool is gathered. Very large does the sheep look with all its wool on. But it is

very slender and small after the shearing. You would not know that it is the same sheep. But it soon becomes large, for the wool grows out again, as your hair does after it is cut.

The wool that is taken from the sheep's back, is very dirty, and is all in a tangle. It is cleaned and made into threads, and then it is ready for use. Very fine must the threads be from which nice broadcloth is made. The threads used in making carpets are very coarse.

Our shoes are made from the skins of animals. The skin of the calf is very commonly used. But the skin has to be tanned, as it is called. The tanning is done by soaking the skins for some time in water, with oak-bark. This makes them into leather.

The India rubber of which your overshoes are made, is used, you know, in making a great variety of other things, such as coats, gloves, foot-balls, pencil-cases, dolls, and so on. When I was a boy, the only use of it was to rub out pencil marks. Every scholar then had a piece of India rubber, as well as a ruler and plummet. If we had been told that it would be used for making so many different things, we should not have believed it.

But what is India rubber? You have seen gum on cherry and peach trees. This gum has leaked out of the tree and dried there. Now India rubber is a gum of a tree. There is a great deal more of gum in the India rubber tree, than in such trees as

the peach and the cherry. Every India rubber tree is a real gum factory. God made it so on purpose, that we might have enough of a gum that can be made useful in so many ways.

The gum that we use is not merely the dried gum. It is baked hard as they gather it. The way that they gather it is this. They make cuts in the trees, and from these cuts leaks out a milky, gummy juice. This they put on balls of clay, drying it by a fire as they put it on. This gives it its dark color.

You have perhaps seen some of the India rubber bottles that are made in this way. The clay is not in them. That has been broken in pieces and shaken out. When India rubber was first used for making overshoes, they were made by drying the gum on clay, formed into the shapes of shoes. They were very clumsy and awkward. But now they have found out a way of making very light and handsome shoes of the India rubber.

Think of the different things that you wear, and tell where they come from. What is cotton cloth made of? Tell about the thistle down. What is cotton wool? What is linen cloth made of? What is tow? Tell about hemp. What are woollen things made from? Tell about shearing sheep. In what is the sheep's wool like your hair? What must be done to wool to get it ready to make cloth? What is one difference between broadcloth and carpets? What are your shoes made of? How is a skin of an animal made leather? Mention some of the things that are made of India rubber. What is the only thing that it was used for till lately? What is India rubber? Tell about the cherry and peach trees. What is said about the India rubber tree? How is the gum gathered? Why is it commonly brought here in the shape of bottles? When India rubber was first used for making shoes, how were they made?

CHAPTER XXVII.

SILK AND SILK WORMS.

Do you ever think, as you look at a beautiful silk dress, that all this silk was made by worms? How strange that they should spin silk out of their ugly bodies! But it is so. Every silk-worm has a spinning machine in it. With this it makes silk, and winds it very curiously in a round hollow ball.

This ball is shaped some like an egg. It is called a cocoon. All that we have to do to get the silk is to unwind it from this ball.

But what does the worm make the silk out of? It is something which it has stored up in its body. It is something which is made from the mulberry leaves that it eats. So we may say that it turns mulberry leaves into silk.

Do you think that any very wise man could make silk out of these leaves? Could he bruise them up very fine, and then draw silk threads out of them? No. Nobody but silk worms can do this. God made them in such a way that they can do it, so that we may use the silk which they spin for us.

When the cocoon is finished, the worm is inside.

This ball of silk is a house which it has built for itself. It is curious to see how it builds it. First, it makes a parcel of loose coarse silk. Then you see it at work in the middle of this. Now it begins to spin its cocoon. It works inside. It turns around its head, and sometimes its whole body, all the time as it spins. After a while the worm has spinned so much that you can not see it at all.

And there it is, all out of sight, covered up by the silk that it has spun. It can not eat any more mulberry leaves. It eats nothing while it is shut up there. It goes to sleep. In about fifteen days after it shuts itself up in its prison, it wakes up. Then it wets one end of the ball to soften it, and out it comes.

But when it comes out it is not an ugly crawling worm, as it was when it shut itself in. It has wings now, and flies about like the moths and butterflies. It is now called the silk-worm moth. How strange it would be if a little boy should shut himself up in a closet, and there change into a bird with wings on, and feathers all over him, and come out and fly off in the air. But this would be no more wonderful than this turning of a worm into a moth.

There is a great deal of silk thread in a cocoon. If it is all unwound without breaking it, there is about six miles of it. It would stretch as far as a man could walk in two hours. How many times the little worm must turn to spin all this !

A pile of cocoons is very beautiful. They are not all of the same color. Some are a golden yellow. Some are a pale yellow, and some are almost white. Some, too, are a light green, and some are a little reddish.

It spoils the cocoons to let the prisoners in them come out. So the cocoons are put into an oven and baked when the worms have done spinning. This kills the worms. Then the silk is easily wound off from the cocoons.

To wind the silk off they must first soak the cocoons in water. The reason is this. The silk is stuck together by a sort of gum, and it can not be wound off while this is dry. The water softens it, and so the silk thread is wound off easily.

They do not bake all the cocoons. They let the moths come out of a few of them. They want them to raise more silk worms. The moths lay a great many eggs. From these eggs the worms are hatched. They are very small at first. But as they eat the mulberry leaves they grow more and more. At last they are quite large worms.

As they grow they have a new skin. They cast off the old one because it is not large enough. They change their coats in this way three or four times. It is just as a boy has a new and larger coat when the old one is too small. The only difference is, that the worm's coat is made on him, but the boy's coat is made and then is put on.

A great noise the worms make in nipping the leaves with their busy jaws. They eat a great deal. Much of what they eat is used in making the soft substance which is to be spun into silk. When there is enough of this made, the worm stops eating, and goes to building his silken house.

What may you think as you look at a silk dress? What is there strange about this? What is there in every silk worm? What is a cocoon? How is the silk got from it? What is the silk made of? Can any man make silk out of mulberry leaves? Why can the silk worm do it? Of what use is the cocoon to the worm? Tell how it makes the cocoon. When the cocoon is done, what then? How long does the worm stay in it? How does it get out? What is it when it comes out? Tell about the boy in the closet. How much silk thread is there in a cocoon? What are the different colors of cocoons? Why are most of them baked? Why must they be soaked in water after they are baked? Why do they not bake all of them? Do the moths lay but few eggs? Tell about the worms changing their skins. How is this different from a boy's having a new coat? Tell about the worms eating. What is most of what they eat made into?

CHAPTER XXVIII.

SPIDERS.

WHAT a spinner the spider is! How fine is the thread which he spins! What do you think that he makes it out of? It is something very soft that is inside of him. And this is made out of what he eats.

The spider, like the silk worm, has a real spinning machine. The silk worm spins from his head; but the spider spins from his tail. He has a multitude of little holes in his machine. Out of these holes are spun threads so small that you can not see them. It takes thousands of these to make the thread that you see in a spider's web.

These threads the spider uses in various ways. He builds his house with them. Look at a spider's web, made in some corner. See what a platform he has built across it with his threads. In at the back part of this platform is his house. It is shaped a little like a tunnel. There he runs in when he is frightened. How quick he will run there, if you put your finger near him as he is walking about on his platform! There he watches for flies. There

he carries the flies that get caught in his web, and sucks their blood out of them.

The spider sets traps for flies. He has threads all about his platform, stretching out this way and that way. Some flies are, like some people, a little careless. They do not take care to keep out of the way of these threads. So they get tangled in with some of them. Then they are caught by the spider and make him a good meal.

Pleasant music is the buzzing of a fly to a spider's ear. There he is in his hole listening. As it comes nearer and nearer, he hopes that it will be caught in some of his snares. Perhaps it is careful, and flies another way as it sees the snares set for it. Then the spider feels very badly. As he hears the buzzing grow fainter and fainter, he says to himself, 'I shall not catch him. Never mind; some fly will come along soon that is not quite so careful.'

Spiders are very apt to quarrel with each other. A spider that has had its web swept down by the housemaid's broom, will commonly go to work and build another web. But sometimes he will go to the web of some other spider, and try to drive him off. Then there will be a great fight between them.

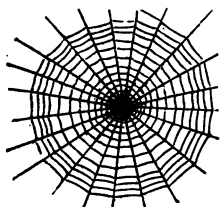
Sometimes a spider, when he becomes old, can not spin any more. His spinning machine is spoilt. Well, what shall he do? He wants a web to live in and catch flies. He finds some younger spider, and drives him from his web, if he can. Then what

will this younger one do? He has lost his home, and all his traps for flies. He does not stop to cry over his loss. He goes to work with his spinning machine, and makes another web in a very little time.

Spiders are ready to build their webs anywhere, if we let them alone. Any corner will do, whether it is in a palace or a shed. The Bible says the spider "is in kings' palaces."

How many spider-houses are sometimes all at once spoiled by a broom! If any corner in a shed or house is let alone for a while, the spiders will get up a little village, as we may call it, for the webs will be quite near together. If some one with a broom sweeps down this spider-village, there is a great scampering of the inhabitants. They run off, and go into cracks and bye-places. But they soon get over their fright, and go to building again, perhaps on the same spot.

So far I have told you only about house-spiders.

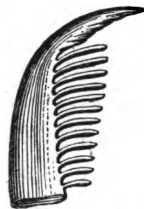


But there are some spiders that live out doors. You sometimes see in the garden, on the bushes, webs shaped in this way. You see this is very different from the web of the house-spider. The garden-spider has some place at the side of its web, under a leaf, where it stays and watches for flies. Each kind of spider has its own fashion for making webs. The webs that you often see in the grass, are dif-

ferent both from the web of the house-spider and that of the garden-spider.

You have often seen spiders' threads stretching from one tree to another. Sometimes they stretch a great distance. Now what are these for? They are the spider's ropes to walk on. But how does he manage them? He spins out a thread, letting the wind blow it as he spins it. Away the end goes, and if it comes to a tree or a fence, it is apt to catch on it. How does the spider know when it has caught on anything? He can not see so far. He knows it by pulling on the thread a little. When he finds that it is fastened, he walks along on it.

There are some, very little and light spiders, that sail away in the air with the thread they spin. They are called gossamer spiders. A spider of this kind lets out a long thread loose in the air. When it is long enough to hold him up, he lets go where he is.



The light long thread is a sort of balloon for him, and he has a grand ride through the air.

There is one kind of spider that makes a raft for itself of bits of sticks and weeds. It floats about on this raft. It is all the time on the watch for some insect that chances to get into the water. If it comes across one, it pulls it on to its raft, and eats it.

Spiders have curious hooks on their claws, by which they hold on to their threads. Some of them

have also combs in their claws. On the opposite page is a picture of one as it looked to me in the microscope. It is supposed that this is used in separating threads from each other when they get tangled together.

What does the spider make his thread of? How is he like the silk worm? In what part of his body is his spinning machine? Tell about the fineness of the threads? What is a spider's web made of? What is the shape of the house part of it? What does he do there? What traps does he set for flies? Tell about careless flies. What is music to the spider? Tell what he thinks as he hears a fly come near and then fly off. Tell about the quarrels of spiders. Tell about the old spiders. What does the Bible say about the spider? Tell about the spider-village and the broom. Tell about the garden-spider. Can you draw his web? What is said about spiders' webs in the grass? What is the use of the spiders' threads that stretch from one tree to another? How do they manage them? Tell about the gossamer spiders. Tell about the raft. What is said about spider's claws.

CHAPTER XXIX.

HABITS OF ANIMALS.

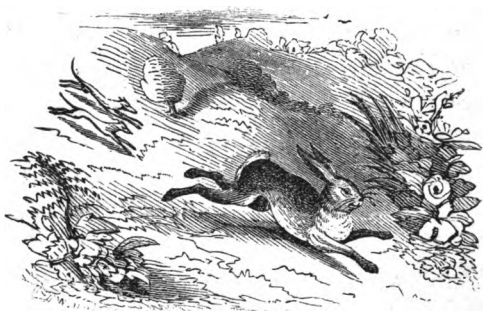
DIFFERENT people have different ways of doing things, and different ways of living. It is the same with animals. They do not all act alike, nor live in the same way. You know that cats have their habits and fashions, and dogs have theirs. So it is with other animals. Each kind of animal has its own way of doing things.

I shall tell you only a few things about the habits of animals. You can learn a great deal about them yourselves, if you will watch animals and see how they do. You will find that you will be amused and instructed by what you see.

Some animals move quickly, and some slowly. You have heard people say, as slow as a snail. And this is one of the slowest of animals. Some worms are very slow crawlers. Toads are apt to keep rather still. They do not hop often, and they never hop very fast.

But some animals are very quick and lively. The little canary bird is always hopping from one perch to another. And most birds are very lively. The

humming-bird is one of the quickest of them. How he will dart off from one flower to another ! And how his wings flutter as he is getting honey from a flower ! Squirrels are very nimble, as we see them running along on a fence, or going from the branch of one tree to the branch of another. Rabbits and hares are great runners. See how swiftly this hare



is running. All the different kinds of flies and butterflies are very lively. How much quicker the grasshopper is in his hop than the toad is !

Most animals are busy in the day time, and sleep in the night. But some are most busy in the night, and are quiet in the day. This is true of owls and bats. Katydid's are still in the day time, but as soon as it grows dark they begin their noise and keep it up all night. Mosquitoes are generally most busy with their singing and biting in the night. Night is the time, too, for hornbugs and moths, and some other insects, to be busy. I suppose they all sleep

in the day time, and at night wake up. Then they fly into our rooms because they see the bright lights there.

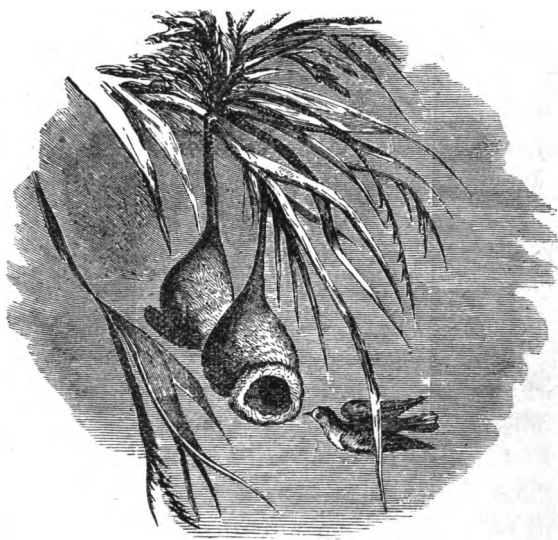
Rats and mice are often very busy in the night. Cats, too, are busy catching them. And when they have no rats and mice to catch, they are apt to get together and make a great squalling. Cats often sleep much in the daytime, because they are about so much in the night.

You know that some dogs are very good at watching in the night. A watch-dog may be fast asleep, and yet the least noise will wake him. If some one goes by in the street, he will hear him and begin to bark. Rogues that want to rob a house are afraid of watch-dogs.

Animals have different kinds of places to live in. Some live in holes that they dig in the ground. The woodchuck and the mole do. Rats and mice live in nests that they build in the walls of houses. I have told you how the spiders live. Wasps live in paper houses. I shall tell you how they make the paper in another chapter. Most birds build their nests in trees or bushes. Some build them on the ground.

Birds do not build nests to live in them, but to hatch their eggs and take care of their young ones. They can live anywhere just as well as in a nest. The canary-bird, you know, sleeps on its perch, and needs no nest, except when it is hatching eggs and raising young birds.

Most birds' nests are very much alike. But some are very singular. The nest of the fire hang-bird, as it is called, hangs like a pocket from the branch of a tree. Here are some curious nests. They are



the nests of some birds that live in India, a country far away from us. They are made in this way so that other animals can not get at them. The door of the nest, as we may call it, is so made that the bird can fly right into it.

Almost all nests are lined with something soft. The birds get hair, or wool, or cotton, or silk, if they can, to make the lining with. The outside

they do not care so much about. They make this often of sticks.

Some birds use a sort of mortar to plaster their nests after they have made them. They really live in a plastered house, as we may say. But it would be rather hard sitting on plaster. So they make the nest soft and comfortable in this way. They put wool, or something else that is soft, all around the inside of the nest while the plaster is wet. When the plaster gets dry, the wool is all well fastened to it. The black-bird makes its nest after this fashion.

You have heard people tell how moths eat cloth, and carpets, and furs. It is not the moths that fly about that do this. They lay eggs in clothes, and furs, and carpets. Then when these eggs hatch, out crawl worms from them. It is these worms that do the mischief. What do you suppose that they do it for? It is to get a good coat for themselves. If one of these worms is in your coat as it hangs up, it steals some of it to make itself a coat. And a very nice one it makes.

But this is not all. What is very curious, the worms live on the same thing that they make their coats of. Just so the silk worm lives on mulberry leaves, and makes his silk cocoon from them also.

When fall comes, the worm goes to sleep, and does not wake up till spring. It gets all ready for this long sleep in this way. It fastens its coat by threads to something. It then closes up both ends of it,

shutting itself up inside. It thus makes its coat into a house, to sleep in till spring. In the spring it eats its way out. But it is not a worm now. It is a moth, with wings. It is changed, just as I told you the silk worm changes in its cocoon.

All the butterflies that you see in the spring have come from worms in the same way. The worms slept through the winter in their houses that they made for themselves, and changed into butterflies. How they are kept from being frozen, I shall tell you in another chapter.

In what is it said that animals are like people? Tell what is said about cats and dogs. How can you learn a great deal about animals? Mention some animals that move slowly. Tell about some that are lively. When are most animals busy? Tell about some that are busy in the night. Tell about rats and mice and cats. What is said about watch-dogs? What animals live in holes in the ground? Where do rats and mice live? What do wasps live in? Where do birds build their nests? What do they want nests for? Tell about the nest of the fire hang-bird. And the nests of a bird in India. What do birds line their nests with? Tell about plastered nests. What eat clothes, and furs, and carpets? What two things do they do it for? In what is the moth worm like the silk worm? How does the moth worm make his coat into a house? When does it do this? When does it come out of its house? What is it when it comes out? Tell about the butterflies.

CHAPTER XXX.

MORE ABOUT THE HABITS OF ANIMALS.

SOME animals live together, and some live separate. Spiders seem to live alone. You never see two spiders taking care of a web, as two birds take care of one nest. You never see two toads keeping company together. But frogs, you know, gather in great numbers in a pond. And sometimes you may see several sitting on a log together.

Most birds go in pairs. Two take care of a single nest. They help each other in hatching the eggs, and in feeding the little birds. Some kinds of birds you often see in flocks. Black-birds and crows you see sometimes in large numbers on a tree. But you never see a flock of robins, or bob-a-links, or blue birds. Hens are apt to keep together some. So are geese and turkeys. Swallows you often see in great numbers flying about some bank of earth, where they have made their nests.

Sheep always go in flocks. And when one goes over a fence, how the whole flock will follow! Wolves often go in flocks, or packs, as they are called. Elephants are apt to be in companies. What

a grand sight it must be to see a company of huge elephants, with their little ones around them! Where horses are found wild, they are not seen alone, but in large companies.

You sometimes see flies in swarms, as they are called. Commonly, however, each fly is by itself. But there are some insects that live together in great numbers. Wasps and bees do. Here is a bee-hive.



A company of bees will swarm in a hive that is made for them, just as some birds will go into little houses made for them, and build their nests there. If no hive is given them, they will find some hollow old tree to live in. The bees build their honey-combs in their hive, and store their honey there. And what is very curious, they have one bee for a queen. She has a place made on purpose for her, and all the bees mind her as people do a real queen.

Ants, you know, live together, and some kinds make large heaps of earth and live in them. I once

saw the inhabitants moving from an old ant-heap into a new one which they had just built. It was amusing to see them tugging away as they carried their grains to their new house. They were as busy as I have seen people on moving days, and worked as hard.

Some animals can be tamed easily, while others can not be tamed at all. People tame horses, and cattle, and dogs, and cats, and so on. Elephants can be tamed. But lions, and tigers, and hyenas, people never think of trying to tame. Here is a

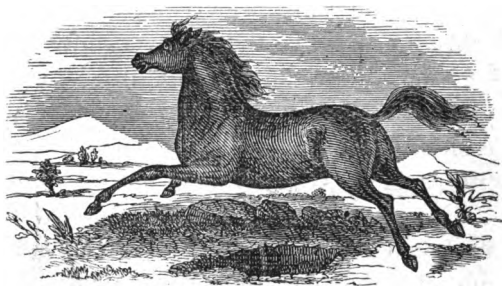


tiger. He is very strong, and could draw well. He knows enough, too, to be of good service. But no one would ever try to put a harness on him. It would not be safe to keep him if he were not in a very strong cage.

The keeper of a lion or tiger may, by long training, make him mind. I have seen a man put his

head into a lion's mouth, and go into the cage where the lion was, and play with him. But the lion would not let any one else do these things. And the keeper never would dare to take him out of his cage, and lead him around among the people, as he does an elephant. Once outside of the bars of his cage, he would not mind his keeper.

I have told you that horses, in their wild state, go in companies. They have a fierce and grand look, as they run with their tails and manes streaming in the air. If you see a horse in a field running, as



you see this one here, it does not seem as if it could be safe to ride him. But let some one catch him and put the bridle on him, and see how gentle he is. How easily the bit in his mouth holds him! But we never could do this with a lion or tiger.

To tame animals well, we have to begin with them when they are very young. The cat must be tamed when she is a kitten. You sometimes see an old cat that has never been tamed. How wild she

is! How her eyes glare! You can not tame her. So, too, horses have to be tamed when they are colts.

People have to be tamed like animals. And they must be tamed young, or it will not be well done. If they are not tamed by their parents and teachers when they are little boys and girls, they grow up as unruly as wild animals. You have heard of breaking horses. It is making them mind, or breaking their wills. This has to be done when they have not been well tamed while they were colts. It is hard work to do it. So it is hard work to break the wills of boys and girls, when they have not been thoroughly tamed while they are very little.

It is curious to see the different dispositions there often are in animals of the same kind. Some are more easily managed than others. It is the same as it is with people. We see this in horses. Some are obstinate, and will sometimes stand stock still when we want to have them go. Others will always mind. Dogs are often different from each other. One dog is apt to bite, while another is not. Some dogs bark at everybody, while others are very still.

There is some difference in cats, too. Some become sober, and even cross, while they are yet kittens. But others are pleasant and playful, perhaps after they get to be old cats. I once had a cat that was rather queer in some things. She always wanted to be with some one of the family, and if she was alone she would mew till she found some one to be

with. But she did not like at all to be fondled. She would not let any one stroke her, or hold her. Her children and grand-children were all like her in this. It was a peculiarity of the family, as we say about people.

What is said about spiders? What about toads and frogs? What is true of most birds? What is said about black-birds and crows? What are some of the birds that you never see in flocks? What is said about hens, and geese, and turkeys? What about swallows? What about sheep? And wolves? Tell about elephants. Are horses alone when they are wild? Tell about flies. How is it said that some insects live? What are some of the insects that live so? Tell about bee-hives. What is told about the ants? What animals can be tamed easily? What can not be? Tell about the tiger. Tell about the lion and his keeper. What is said about wild horses? Tell about the horse in the field. What is said about the time for taming animals? What about taming people? What is breaking horses? What is it like? What is said about the dispositions of animals? What is said about horses—and dogs—and cats? Tell about the queer cat.

CHAPTER XXXI.

SPORTS OF ANIMALS.

Most animals like play just as you do. See how the kitten plays with a string, or anything else that she finds. She will play with her tail if she can not find any other thing to play with. Round and round after it she will go, like a top. Two kittens will often play together as children do. They will run after each other, throw each other down, roll over together, and so on. Dogs will do so too.

When cats and dogs get to be old, they, like people, become sober, and so they will not play. But old people, you know, often like to see children play. So, too, the old cat seems to look on with pleasure when her kittens are playing about her. She sits there looking round and purring away as if she was very well contented. If the kittens, however, push against her, and tumble over her, she does not seem to like it. So old people do not like to have children, as they play, run against them, and pull the chairs which they are sitting in.

It is amusing to see the lambs skipping about the field in their sport, while the old sheep look gravely

on, or are busy cropping the grass. Horses are often frisky after they get to be quite old. I have often laughed to see an old horse, on getting loose, run about rearing and kicking up his heels like a colt. Even oxen will sometimes play a little, though commonly they are very sober. From the noise that rats often make in scampering about, I think that they are rather playful animals. And I suppose mice are too. Such large animals as whales and elephants have their sports.

But there are some animals that do not appear to play at all. They always look and act as if they were very sober. All they seem to care for is to get enough to eat, and have a good easy time of it. You never see spiders playing, though I think the gossamer spider must have great sport in flying off on his thread balloon. Toads do not play. The owl is always very sober. All its sport seems to be to sit in a tree and hoot. I do not believe that such beasts as lions and tigers play much.

But more animals have sports than is commonly supposed. Some man once, while watching some ants, saw them playing together like children. You know that they are very industrious animals. But they have their times for play. They run about and try to catch each other. They dodge behind sticks and spires of grass. One will carry another on his back. They will set out on a race together. They play together like kittens. They are as fond of fun

and play as you are. They can work all the better for it when it is time to work, as you can study better after you have been out to play. Ants in some things are like people.

You know that it is said, all work and no play makes Jack a dull boy. And a dull ant would be that would always be at work, and never play with other ants.

How pleasant it is to you, when school is done, and it is time to play, to hop and skip and jump. You like to be active. It would be very hard for you to keep your limbs still all the time. So it is with animals. How active the birds are! How they hop from twig to twig, and fly about in their joy! Grand sport it is for them. And when they are shut up in a cage they feel as if there was not room enough for them, and they would be very glad to get out and fly about like other birds.

Did you ever think how happy the insects are as they fly about? See that flock of yellow butterflies flying so quickly here and there. They are enjoying themselves in the same way that boys and girls do as they run about together. Perhaps you have sometimes seen a great many very little insects going up and down and round in the same spot, in a sort of whirl. They go so fast that it almost makes you dizzy to look at them. What is this for? They are not at work. They are at play. They are enjoying themselves just as much as they can.

When children are at play they are not apt to be still. They make considerable noise. They chatter, and laugh, and shout. So it is with many animals. When they are happy they let us know it with their voices, if they have voices. The birds chirp and sing as they fly about together. Some of the insects sing, some buzz, and some chirp, and there are various other noises that are made by some of them.

What is said about animals playing? Tell about old cats and dogs. Tell about the cat with her kittens playing around her. What is this like? Tell about lambs—and horses—and oxen—and rats—and mice. Do large animals play? What is said about sober animals? Tell about some of them that are mentioned. Tell about the ants. How are ants compared with boys? What is said about children's loving to be active? Tell about the birds. And the butterflies. And the little insects. What is said about the noise of children and of animals in their play?

CHAPTER XXXII,

ANIMALS IN SUMMER AND IN WINTER.

How many animals there are in summer, and how busy they are ! If we go out into the garden and look about, we see a great variety of animals everywhere. The birds are flying among the trees and bushes. The bees are gathering their honey, and the butterflies are flying about from flower to flower. The grasshoppers, too, are very busy, hopping their long and quick hops. And as we walk along, we see here and there a toad hop to get out of our way. We see everywhere a great number of bugs and worms crawling about on the plants, and on the ground. We see, too, a multitude of flies. Some of them are very large, and some of them are very, very little things. Then there are the busy ants, and the spiders with their webs.

Now in the winter all this busy life is gone. If we go out into the garden then, we see none of these animals. Where are they ? I will tell you.

Some kinds of animals are dead. They have laid their eggs, and these will be hatched when the warm weather of spring comes. This is true of spiders

and grasshoppers, as you will remember that I told you in Chapter XIII.

Many of the worms have shut themselves up in nice coverings, to have a long sleep through the winter. When spring comes, they will wake up and eat their way out of these coverings, and they will then be butterflies. This I told you about in Chapter XXVII. The coverings are very nicely made. They are fastened to a branch of a tree, or perhaps to some wall. You will perhaps ask how the worm is kept from freezing in the cold weather. The covering is made very tight, and then it has a soft lining on the inside. This is the worm's blanket, to keep it warm. And besides, there are two other coverings inside of this blanket before you come to the worm.

Some of the animals have crawled into some hiding place, where they will sleep through the winter. The toads have done this. They will wake up in the spring, and begin their hop, hop, again.

What do you think has become of all the birds? There are their nests on the trees and bushes, but you see no birds in them. They have all gone south to spend the winter, and will come back again in the spring. They could not live here in the cold weather of winter.

There are some kinds of birds that we see going in flocks to the south in the fall, and to the north of us in the spring. We see the wild geese as they

fly over. They fly in regular order, and seem to have a leader. They are quite large birds. Here is a picture of one of them.



In these long journeys that birds take every year, they every now and then stop and rest. Some fly in the night, and then rest in the day. This is the reason that we do not see more of the birds as they go north or south.

I saw a flock of beautiful little birds in my garden very early this spring. They alighted on an apple tree, and were very busy in picking at some rotten apples, that had been on the tree all the winter. They were soon gone. I suppose that they had been south to spend the winter; and they were now on their way to spend the summer north of us, perhaps in Canada.

You have seen the bob-o-link and heard his lively song! What a chatter-box he is, as he sits on the topmost branch of a tree, swinging back and forth in the wind! You know that his feathers are some black, some white, and some rather yellow. He is

quite a bright looking bird. But when he goes south he changes his coat. He now loses his bright colors, and becomes a russet-colored bird. He leaves off singing, too, and you hear only a little chink. In the middle states he is called the reed-bird, because he is seen on reeds and tall grasses, living on their seeds. But when he gets far south he lives on rice, and is called the rice-bird.

It seems very strange that such a singer as the bob-o-link is, should all at once give up singing, and not sing again till the next spring comes. But it is no more strange than what happens to the canary-birds. When they are moulting, or changing their coats, they do not sing. It is the male bob-o-links that do all the singing, just as it is with the canary-birds. And the female bob-o-links never have the bright plumage. They are always russet-colored.

Tell about the various animals that you see in a garden in the summer. How is it in winter? Mention some of the animals that are dead then. Tell about their eggs. What has become of many of the worms? What will happen to them in the spring? Tell about their winter coverings. How are they kept from freezing? Tell about the toads. What has become of the birds? Tell about the wild geese. Why do we see so few of the birds as they go south or north? Tell about the flock of birds in the garden. Tell about the bob-o-link. How is he changed when he goes south? What does he live on in the middle states? What when he gets to the south? What is said about his stopping his singing? What is said about the female bob-o-links?

CHAPTER XXXIII.

MAN AND ANIMALS.

WE are very much like many of the animals that we see about us in some things. They have hearts and stomachs and lungs a good deal like ours. Their bones and muscles are like ours.

But we are very different from them in some things. And some of these I will tell you about.

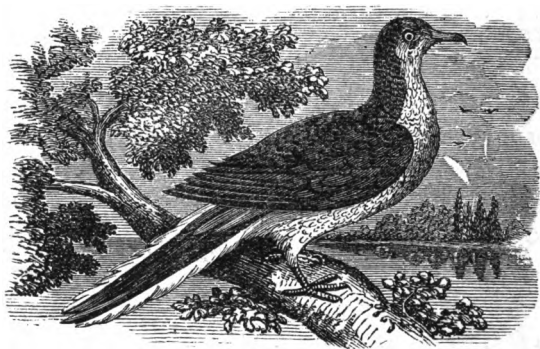
There is no animal but man that has a chin. Your chin, you know, sticks out below your mouth. But there is nothing of this sort below the mouth of your cat. So, too, there is no chin on the faces of dogs, horses, cows, pigs, and so on.

None of the beasts can laugh or smile. Perhaps you will say that a dog smiles when he is pleased. He looks up at you, but he does not smile, unless you call wagging his tail smiling.

Most large animals walk on four feet. Insects have more than four feet. Flies have six, and spiders eight. Many insects have a great many feet. Man has only two. Birds have two feet, but they do not stand up straight on them as we do. Look at the picture of a bird on the next page, as it stands on the

branch of a tree. Its legs are crooked, and its body is not straight up and down, as our bodies are when we stand. Monkeys sometimes stand up, but it is rather crooked standing. And they never stand unless they are told to do it by their keeper. When they have their own way they go on all fours.

Man is the only animal that talks. A great many animals have voices, and many of them sing. But none talk. Parrots are said to talk. But it is not



really talking. The parrot never says anything of itself. It only mimics talking. If it never heard any person talk, it would not say anything.

Animals that live where it is at all cold, have coverings on them to keep them warm. In very cold countries, they are covered with fur. But the skin of man is naked. This is because he knows enough to make such coverings as he needs. But other animals do not know enough for this. So

God gives them their clothes, as we may say, ready made.

Man knows a great deal more than any other animal. He does not at first. When he is a baby, he is very much like dogs and cats, and other animals. He learns as they do. But after a while they stop learning. They have learned about all that they can. But he keeps on, and when he comes to be a man he knows a great deal. And he can always be learning as long as he lives.

As man can talk, he can tell others what he knows. As he can write and print, he can make books. And so what he learns he can leave for others to learn after he is dead. But when an animal dies, his wisdom dies with him. He can not tell things to other animals. He can not write or print what he knows.

No other animal but man has a hand. Many have paws, but these are very little like hands. Some say that the monkey has four hands. But this is not so. His four paws are more like hands than the paws of other animals are, but they are not really hands. He can do with his paws very few of the many things that you can do with your hands. What you can do with your hands, I will tell you in the next chapter.

Man understands some things that animals can not understand. If you should tell a story to a cat, or a dog, it would not understand it at all. Children sometimes tell stories to cats, but it is only in fun,

just as a little girl tells stories to her doll. An old cat can not understand a story any better than a kitten can. But though it is of no use to tell stories to a little baby, he will get so as to understand them long before he grows up to be a man.

There is another difference between us and other animals. When they die, that is the end of them. But it is not so with us. Our souls live after our bodies die. They will live forever.

What I have told you about the death of animals, is true of the very best of them. If a little bird that you love dies, it is sad to think that you never again will see it, or hear its sweet song. And if a man's faithful dog dies, he feels very sad when he thinks that so good a friend is gone forever. But when any person dies that we love, we know that we shall see him again in another world, because the Bible tells us so.

How are many animals like us? What is said about chins? What about smiling and laughing? How many feet have most large animals? How many feet have flies? How many have spiders? Tell what is said about birds. And about monkeya. What is said about talking? What about parrots? Tell about the coverings of animals. Why is the skin of man naked? What is said about man's knowledge? Does he know more than other animals at first? Tell about the difference between their learning and his. In what ways can a man tell others what he knows? How are animals different from man about this? What is said about animals having hands? Has the monkey hands? If you tell a story to an animal, will he understand it? Why not? Tell about the kitten and the baby. What difference is there between man and animals about dying? Tell about the bird and the dog. How do we know that it is different when a person dies?

CHAPTER XXXIV.

HANDS.

DID you ever think how many things your hands can do? There are a great many things that your hands can do alone, and then, there are a great many more things that they can do with tools that they hold.

Let us see first what your hands can do alone. They can point, mark, punch, push, poke, pick, scratch, strike, pound, stroke, rub, dig, pull, lift, carry, roll, toss, throw, scrape, scoop, squeeze, wring, pinch, hook, knead.

Every boy knows that he can use his hands as a cup to catch water with to drink.

The hands are used a great deal in gesturing when people are talking. Sometimes we talk with the hands alone. When we make motions with them that people can understand, we make the hands talk. We sometimes call persons to us by beckoning with the hands. What we mean is just as plain as if we called them with our voices.

Persons that are deaf and dumb, do most of their talking with their hands. They do it partly by ges-

turing, and partly by using a finger alphabet. I tell about this alphabet in the Child's Book of Nature, in Part Second, Chapter XXI.

If you will make all the motions in doing the things that I have mentioned, you will see what a wonderful instrument the hand is. There is one motion that I hope you will make only as a motion. I mean striking. You can make believe strike, but I hope that you will never be so ill-natured as to really strike any one.

I have not told half of what your hands can do. I have only told what they can do alone, without tools and instruments. With these how many things the hands can do! I will mention some of the tools and instruments the hands use in doing things, and you can think of others. There are axes, hoes, spades, whips, hammers, wheel-barrows, knives, forks, spoons, oars, pens, needles, ropes, threads, and so on.

See how differently the hands take hold of these things in using them. See a man grasp a rope, and then see him take the finest thread between his fingers. See a man wielding an axe, and then see him writing with his pen.

There is one thing which we do with our hands that I have not mentioned. We feel with them. And how nicely we can do this. Move your fingers over anything very smooth, and you can feel the least roughness there is.

I have called the hand an instrument. See what it is made of. Its framework is bones joined firmly together. Then there are cords to make these bones move. And there are a great many blood-vessels and nerves. All these things are covered up with the skin. The cords that work the bones, you can see under the skin in lean persons.

The hand, as you look at it, with its four fingers and its thumb, seems a very simple thing. It does not look as if it could do so many things as it does.

How very few things animals can do with their paws! The paw of a cat or a dog can do some things very well indeed. But it can not do anything like as many things as your hand can. Here is a



squirrel holding a nut with his paw. This is about all that he can do with his paws besides running.

You never see an animal take anything in its paw to do things with. It never takes a knife and cuts.

It never takes a stick to strike with. It never makes tools, and never uses those that men make.

Some birds sew leaves together in making their nests. But they do not use needles. They would not use them if you should put them in their way. Their bills are their needles; for with them they make the holes in the leaves, and put the threads through the holes.

Such animals as elephants and monkeys can be taught to use things of various kinds. But they will use them only when they are told to do it. I have seen an elephant take a whip with his trunk, and strike with it like a teamster. But he did it only when his keeper told him that he must.

It takes a long time for us to learn to do so many things with our hands as I have mentioned. The baby can use his hands but very little at first. He can not hold anything. He does not put out his fingers and feel of things with them, as you do. He has to learn to do the simplest things with his hands.

He uses them very awkwardly at first. If he puts them up to his face to rub it, he is very apt to scratch the tender skin with his nails. He learns after a while to turn his little nails away as he rubs. So, too, when he first begins to hold things, he does it in a very clumsy way. But after a while he learns to do it very well.

We learn to use our hands, you see, by little and

little. Some after a time get to use their hands with great skill. They do very nice things with them. How skillfully some play with their fingers on musical instruments! How beautifully some write! What fine lines some can make in drawing!

Can you do but a few things with your hands? Mention some of the things that you can do with your hands alone. Tell about using them for a cup. Tell about using them in gesturing. Tell about talking with the hands alone. In what two ways do the deaf and dumb talk with their hands? How can you see what a wonderful instrument the hand is? What is said about the striking motion? Mention some of the tools and instruments that the hands can use? What is said about the different ways in which the hands use them? What is said about feeling? What is the hand made of? What is said about its being a simple instrument? What is said about the paws of animals? Tell about the squirrel. What is said about animals taking things in their paws? Tell about the birds' sewing. Tell about elephants and monkeys. What is said about learning to use the hands? What about the skill with which some use them?

CHAPTER XXXV.

FEET.

OUR feet are not used for as many different things as our hands are. They are used for walking, running, leaping, climbing, pushing, kicking, &c.

The feet of different animals are made differently, just as they need. The feet of the squirrel are so made that he can climb trees, and run out to the very ends of the branches. He can hold nuts, too, with his fore feet, while he makes holes in the shells with his sharp teeth. But the feet of the horse and cow are not made in such a way that they can climb, for they have no need of climbing. So, too, they have no need of holding their food between their fore feet. Their feet are needed only for walking and running, and so are fitted for doing these alone.

A cat's foot is worth thinking of a little. See those cushions. What are they for? Why does she not have such hard feet as cattle and sheep and goats have? There are two reasons for it. A cat wants, once in a while, to jump down from a high fence or a tree. If she had hard feet, the jar would hurt her as she came down upon them. But with her cush-

ioned feet she is not jarred at all. Another reason is this. With her soft feet she can get near rats and mice without their hearing her. Did you ever hear sheep or goats run over a floor? What a clatter they make! A cat with such feet could never catch a rat or a mouse. It would be off to its nest long before she could get near it.

But I have not done with the cat's feet yet. Take one of them in your hand as your cat lies asleep in your lap. How soft it is! •And how harmless and gentle a thing it seems to be! It does not look as if it could scratch and tear. But there are very sharp and strong claws there all covered up. See her when she is fighting with another cat, or is killing a rat. Now the claws have come out from their hiding places, and the paw that was so gentle, is ready for scratching and tearing. And when she climbs a tree, out come the claws for her to hold on with.

Look at a horse's foot, and see how thick the hoof is. It is about the same thing with the nails on your toes and fingers, only it is very thick. It is made so because the horse wants it to run on. A soft foot would not do for his rough work. Why is it that they nail iron shoes on to the hoofs? It is because they would become very ragged and broken, as the horse travels over rough and stony ground, if he was without these shoes.

Most birds' feet are made in such a way that they can take firm hold of a branch of a tree, or anything

of that shape. You know that they do not lie down when they go to sleep. They sit down on their feet, as we may say. How is this? What keeps them from falling from their roosts when they are asleep? It is the cords of their legs. When a bird gets on to its roost, it does not stand up straight, but settles down, so that its legs are quite crooked. This makes the cords pull the toes so hard, that they grasp the roost very tightly. Boys sometimes get chickens' legs, and amuse themselves in pulling the toes with these cords.

The feet of ducks and geese are made very differently from the feet of most birds. They have a skin or web between all the toes. They are called web-footed animals. Their feet are made in this way so that they may swim in water.

A duck, as he swims along, uses his feet as a man does oars in a boat. He presses with them backward against the water, and this makes him sail along. But he does not keep taking them out of the water and putting them in again, as the man does with his oars. He keeps working them in the water. But how does he work them? When he moves them backward, he spreads them out like an open fan. This makes him go forward. Now when he moves his feet forward, if he kept them spread out, they would stop his going forward and make him go backward. But he does not manage in this way. As he moves the feet forward he gathers up the toes together

like a shut fan, and so they go through the water easily.

Flies, you know, walk right up a smooth pane of glass, and also walk over head on the ceiling with their backs downward. They must have rather queer feet to do these things with. If we look at a fly's foot through a microscope, we see two sharp hooks, and then two broad spreading things very curiously made.

But wise men do not agree as to the way in which the fly uses its feet. If we could with the microscope see a fly use its foot, we could say who are right about this. But we can not. We can only look at the foot by itself.

Some suppose that the spreading things are suckers, and that when the fly walks on the ceiling, or up a pane of glass, it holds on by these. But some think that the hooks are the chief things that the fly uses. Perhaps you will say that the glass is so smooth that the hooks could find nothing to hold on to. But the microscope shows us that the smoothest glass is rough enough for such very little hooks to be of some service. Those who think that the hooks are what the fly walks with up glass, say that the glass is as rough to these little hooks as a tree is to a cat's claws.

There are others who think that they have proved, that there is a sort of glue on the fly's foot, with which it sticks for a moment to anything that it presses on. They put flies into glass vessels, and

then breathed into them till the glass was all covered with moisture. The flies now could not walk up the glass. The glue would not stick. They found, too, that a fine powder on the glass would keep the fly from walking up on it. Besides all this, they could see with the microscope the tracks of glue which flies make on glass.

Which are used for the most things, our feet or our hands? What are our feet used for? What is said about the feet of animals? Tell about the squirrel. And the horse and cow. For what two reasons does a cat have cushions on her feet? Tell about her claws. What is said about the hoofs of a horse's feet? Why are iron shoes nailed on to them? What is said about birds' feet? Why do they not fall from their roosts when they are fast asleep? Tell about the chicken legs. How are the feet of ducks and geese different from the feet of most birds? How does a duck manage his feet as a man does oars in a boat? In what is it different? Tell just how he uses his feet in swimming. Tell about the walking of flies. Describe a fly's foot as we see it in a microscope. How do some think that a fly walks up a glass or on the ceiling? Tell what some think about the hooks. Is glass so smooth that the hooks could not hold on to it at all? Tell about the glue. Tell about the experiments with the glass vessel. Tell about the tracks of glue.

CHAPTER XXXVI.



THE SENSES.

THERE are five senses,—sight, hearing, smelling, the taste, and the touch. Which is the most useful to us? The sense of sight. Why? Because we learn more by this about things than we do by any other sense. For this reason it is worse to be blind than to be deaf and dumb.

The deaf and dumb can go about anywhere, and see all kinds of things. But the blind have to be led, and they learn mostly by hearing about things. They learn a great deal by the sense of touch. They feel things very carefully all over. There are books made for the blind to read. They read them with their fingers. The letters are raised up, so that they can tell their shape by feeling them.

The blind know a great deal by the sense of smell. A scholar in a blind school knew by the smell what they had to sell in different shops as he passed them. He would say, as he went along, this is a shoe store, this is a grocery, and this is an apothecary's shop.

What is the reason that those who are entirely deaf are always dumb? Are their throats made in such a way that they can not speak? No; they are made as well as yours is. Why, then, can they not use them like you, and speak. It is only because they are deaf. A child can not learn to talk if he can not hear. When he is learning to say anything he tries to say it as he hears others say it. And when he gets it right he is very much pleased. Now if he can not hear, he never can know whether he gets it right. And so he will not try to talk.

Did you ever think how silent the world is to the deaf and dumb? They do not hear the loudest noises that can be made. If you are in a room all alone in a still night, it seems very still to you. But to the deaf and dumb the world is stiller than that.

When it is so still that we say there is no noise, there is some. Go into a room by yourself, and put a shell up to your ear. You will hear a sort of roaring sound. What is it? It is not a noise that the shell makes. It is some of the noise that is in the room, that goes into the shell and whirls about in it. So you see that the world is more still to the deaf and dumb, than it is to you in the stillest place that you can find.

To the blind the world is all dark. If you go into a very dark room you can see a very little, because there is some light there. But to the blind it is as if there is no light at all.

How much enjoyment you have from your senses ! You love sweet things. Why ? Because they are sweet to the sense of taste. But there are many things which are not sweet that are pleasant to the taste. There is great variety in the enjoyment that we have by this sense.

Then there is the sense of smell. What a variety of pleasant-smelling flowers and other things God has made for us.

But we have more enjoyment from the sight and hearing than from the other senses. How delightful is music to our ears ! How charming the warbling of birds in a bright spring morning ! But the best of all sounds are the voices of those whom we love. How delightful to a parent the joyous prattle of childhood ! And how the child loves to hear the sweet gentle voice of its mother.

And then the beautiful things that God has given us to look at, how many there are ! There are the bright sunlight, the moon and stars, the flowers, the trees, the birds, the butterflies. These and many other things continually delight our eyes, as I have told you in Chapter XXV.

There are some that do not seem to care much about the beautiful things that they can see, and the pleasant sounds that they can hear. They care most about what they are to eat and drink. Such greedy ones seem to think that the taste is the best of the senses. It is well to enjoy eating. But God does

not like to have us think too much of it. And he likes to have us think a great deal of the sweet sounds with which he fills our ears, and of the beauties which he has placed all around us.

What are the five senses? Why is the sense of sight the most useful to us of them all? In what ways can the blind learn? Tell about the blind scholar and the shops. Why are those who are entirely deaf, dumb also? How does a child learn to talk? How still is the world to the deaf and dumb? Is it ever as still to us? Tell about the shell. What is said about the darkness of the blind? What is said about the enjoyment that we have from the sense of taste? What about the sense of smell? From what senses have we the most enjoyment? What are some of the pleasant sounds that we hear? What some of the beautiful things that we see? What do some foolish persons care most about? What does God like to have us think a good deal of?

CHAPTER XXXVII.

WRITING AND PRINTING.

PRINTED books are such common things now, that perhaps you think that people always had them. But it is not so. It is not a very great while since the way to print was found out.

When our Savior was upon the earth, there was no printing. They had the Old Testament then, but it was not printed. It was written. One copy of it was written from another. And there were a great many persons that made it a business to copy books.

The New Testament was copied in the same way. And there was no printing for a very, very long time after this. If any one wanted a book of any kind, the only way to get it was to have a copy made of it by writing.

This is a very slow way of getting a book. It takes a long time, you know, to copy only a few pages. But printing is quick work. The way that it is done is this. The types, you know, have the letters on the ends of them. They are all fixed right in a frame. Then the ink is put on the types, and

they are pressed on the paper. You can see that they would leave on the paper the print of the letters.

Now the types can be inked again, and the same thing can be printed on another sheet of paper. And you can go on and make as many copies as you please. A great number of copies can be made in the same time that it would take to make a single copy by writing.

Many years ago people did not know how to make paper. So the writing was done on other things. The smooth inner bark of some trees was one of the things they used. Perhaps you have sometimes peeled off bark from birch trees. You can see how you could write on it, though, it is not anything like as good as paper is. There are some kinds of bark better than this in some countries.

Leaves were sometimes used to write on, by scratching letters on them with something sharp.

Sometimes they wrote on the skins of animals. Skins were prepared for this by scraping them so as to make them quite thin, and then dressing them. Linen and cotton cloth were also sometimes used to write on.

In Egypt they made a sort of paper out of the stalk of a plant, in this way. The stalk was slit into very thin strips with a needle. Then these strips were laid very carefully together, and were wet with water from the river Nile. When they

became dry they were well glued together. This paper was called papyrus.

All the books of the Old and New Testaments were written on some of the things that I have mentioned. And it was a long time after this that people found out how to make paper. I shall tell you how it is made in another chapter.

It was a great thing for the world when people found out how to make paper, and how to print on it. When books were made by copying with a pen, they cost a great deal of money. Only a few people could have them. But now, by means of printing, people can make so many books in a little time that they are very cheap. The poorest people can have the Bible, and as many other books as they need.

There were no newspapers before printing was discovered. Did you ever think what a good thing a newspaper is? It tells us all about what has happened, and other things that are useful to us. It would be very slow work to find out about all these things if we did not have newspapers.

A great many things have to be done to make a newspaper. I will tell you about this. The man who has charge of it is called the editor. He writes some things on pieces of paper, and then the printers set the types so as to print just what he has written. He looks over newspapers that have come to him from all parts of the country, and cuts out pieces that he thinks people would like to read. He gives

these to the printers, and they set the types to print them. Some people send him pieces that they have written to be printed in the paper. Advertisements about what is for sale, and about other things, are sent to him. He puts in, too, all the deaths and marriages. Any thing that happens he puts in if he thinks the people would like to hear about it. He gets news by the telegraph, and that is put in the paper. Sometimes he sends a man to a meeting, who writes down what is said and done, and this is printed.

Have people always had printed books? What kind of books did they have when our Savior was upon the earth? Did people begin to print soon after this? When there was no printing, how did people get books? Is copying books quick work? How is it with printing them? What are types? How do they print with them? Tell about writing on bark? What other things were used to write on? How are skins prepared so as to write on them? Tell about the papyrus. Was any of the Bible written at first on paper? Was there a plenty of books before people knew how to make paper, and print on it? How is it now? Of what use are newspapers? What is the editor of a paper? Tell all the different things that are done in making a newspaper.

CHAPTER XXXVIII.

PAPER.

THE paper that people write and print on is commonly made out of rags. Before they knew how to make paper the rags were thrown away. But now they are all saved, and there is so much paper wanted that the paper makers can not get rags enough.

Families all about the country keep rag-bags. Into these they put all their rags, and then sell them to have paper made out of them. In cities it is quite a business for some poor people to pick up rags in the streets. These rag-pickers go about with a basket in one hand, and a hook on the end of a stick in the other. They hook up the rags in the gutters and put them into their baskets.

If you see a heap of rags they do not seem to you to look much like paper. How good clean white paper is made out of them is a puzzle to you.

I have seen them make paper for newspapers, and I will tell you some things about the way they do it.

First they clean the rags, and then they put something with them to take all the color out of them. Then they grind them up fine, and after a while you

see the rags all turned into a sort of white porridge. This is ground rags and water together.

The next thing is to let this rag-porridge run over a long fine sieve. This sieve lets the water drip through. By the time that the porridge gets to the end of the sieve it is changed into paper.

But the paper is wet, for all the water has not dripped through. It must be dried now. This is done in a very pretty way. The paper is made to go off from the sieve over some great round smooth rollers. These rollers are full of steam, and so are quite hot. This dries the paper and makes it smooth.

The paper keeps making all the time. The rag-porridge is always running on to one end of the sieve. At the other end the paper is passing off to the rollers to be dried.

The paper slides off from the rollers to where there is a great pair of shears. Here it is cut off sheet by sheet. The sheets are all of the same size. This is because the shears work as regularly as a clock ticks. They always cut the paper at just the right time. The shears are not worked by hand. The machine works them. A girl sits before them, and as fast as the sheets drop she picks them up and lays them in a pile.

A sheet of the finest letter paper is nothing but threads of rags fastened together. You will think that this can not be so, because the paper is so very smooth. But I could show you that it is so by letting you see a little piece of paper through the mi-

roscope. It does not look smooth now. Little bits of thread lie across each other, tangled together in every way. These threads you can see sticking out all along the torn edge of the paper. In coarse paper you can see the threads without the microscope.

Paper is made out of other things besides rags. Straw, hay and old ropes are used in making coarse wrapping-paper. Some kinds of wood are sometimes used. The wood must be ground up very finely to make paper that is at all smooth. Very good paper for printing is made out of wood.

Wasps were the first paper makers. They have always built their nests of brown paper. And this paper they make themselves out of wood. They bite off little bits of wood from fences and boards. These they grind up well in their mouths, wetting it with their saliva as they grind. They make a sort of wood-porridge in this way. Out of this they build their nest. And if you look at a wasp's nest, you will say that the brown paper which the wasps make is much like that which men make.

What is paper commonly made of? What was done with rags before people knew how to make paper? Tell about the rag-bags. And the rag-pickers. In making paper what do they first do to the rags? What next? And what next? Tell about the rag-porridge. How is this changed into paper? How is the paper dried? Tell how the paper keeps making all the time. Tell how it is cut into sheets. What is a sheet of fine letter paper? If you look at a bit of it in a microscope what do you see? How does the torn edge of it look? What things besides rags is paper sometimes made of? Who were the first paper makers in the world? What do they make their paper of? How do they make it?

CHAPTER XXXIX.

LIGHTNING AND THE TELEGRAPH.

DID you know that there is lightning in the back of a cat? There really is. If you stroke a cat's back you can sometimes feel a shock in your fingers. The colder the weather is the more you will feel it. You will think it strange when I tell you that your fingers are struck by lightning when you feel this shock. The shock is but a little one. Perhaps it is only a little tingling. This is because there is only a little of the lightning. But though there is only a little, you can sometimes see the spark that it makes when you stroke a cat in a dark room.

Lightning, or electricity, as it is commonly called, is then not all up in the clouds. It is in a great many things. You have some lightning in you. Some persons have so much in them that they can light the gas without any match. They do it in this way. They walk along on the carpet moving their feet on it. This wakes up the lightning, just as rubbing the cat's back does. Then by putting the finger to a gas-burner they let off some of the lightning, and the gas is lighted.

You have seen lightning rods on houses. How do you think they keep houses from being struck with lightning? They do not drive the lightning off. This is not the way that they keep it from a house. I will tell you how it is. When the lightning comes to a house, if there is a rod on it, it will go down the rod into the ground, and not touch the house. This is because it likes iron so well. It likes it a great deal better than it does wood, or brick or stone. It will go on to iron wherever it can find it.

Now you know that the wire that stretches along from one telegraph post to another is iron wire. In working the telegraph, lightning is made to go along this wire, from one place to another. It keeps on the wire all the way because it likes it so well.

You know that there are glass knobs on the poles for the wires to rest on, and the wire does not touch the wood at all. What is the use of these? Why would it not do just as well if the wire went through a hole in each post? A little boy in a school where I asked this question, said that the lightning would have to jump over the top of every post. I suppose that he had seen squirrels jump over the tops of the posts as they run along a rail fence, and thought that the lightning would do the same. But he did not remember that the squirrel always goes through the hole in the post when it is large enough. Now the lightning does not need much room to go through.

If the hole in the post should be so small that the wire would fit tightly in it, there would be room enough for the lightning to pass. There is but little of it, and it keeps very close to the wire.

There is some other reason then for having the wire rest on the glass knobs. It is to keep the lightning from leaving the wire. If the wire touched the posts, some of the lightning would go down the posts. And so the lightning would all be lost long before it reached the end of its journey. Why would it go down the posts? Because it likes wood. Though it does not like wood as well as it does iron, it likes it some. But glass it does not like at all. So none of it will go on to the glass knobs and run down the posts.

You sometimes see birds sitting on the wires. The lightning must go along between their toes. This is because it likes the iron best. If it did not, it would go off into the birds and give them a shock.

But where do they get the lightning that they send along the wire? They make it with a machine. If they want to send messages from New York to New Haven, they make lightning in the office at New York, and then let it go along the wire that leads to New Haven.

They have to send only a little lightning at a time. It is so little that you can not see it. That little goes its journey on the wire very quickly. It takes almost no time for it to go thousands of miles. It

would take a man a great many days to travel as far as the lightning goes in a moment.

When the wire is broken anywhere, the lightning will not go to the end of its journey. It will stop just where the break is. No messages can be sent till the wire is mended.

Tell about the lightning in a cat's back. Why is the shock that you get a little one? How can you sometimes see the spark? What is lightning often called? Is it in only a few things? Is it in you? Tell how some persons can light the gas with it. How do lightning rods keep lightning from a house? Why does it go down the rod instead of going into the house? Tell about working the telegraph. What did a boy say about having the wire go through the posts? Why was he not right about it? What is the reason for having the wire rest on glass knobs? Tell about the birds. Tell about making lightning in the telegraph offices. Tell about its going so fast. When the wire is broken, what happens?

CHAPTER XL.

MORE ABOUT THE TELEGRAPH.

SOME people have strange ideas about the telegraph. They think that papers with messages on them are sent along the wires, as boys sometimes let the wind blow papers up on the string of a kite. Such people wonder that they can never see the papers as they look up at the wires. An Irish girl said to a lady, "Why don't you send bundles by the telegraph? You know it is so quick, ma'am."

An old woman, who was very ignorant about such things, wanted to send a pair of new boots to her son. She wrote a letter in which she asked him to send back his old boots to be mended. Then she fastened the letter to the boots, and tied them to a telegraph post. The boots were stolen by some one, who put an old pair in their place. The next morning the woman went there and found this pair of old boots. She thought that the telegraph was a very wonderful thing, because it did business so quick.

But most people understand about the telegraph. They know that it is lightning, or electricity, that goes along the wires, and gives the messages. But

you will want to know how the messages are given. One way is this. An alphabet is made for the lightning. "What!" you will say, "teach the lightning an alphabet, just as we are taught!" Oh, no. I do not mean that. I will explain it to you.

Suppose that a telegraph-man in New Haven agrees with one in New York that one dot shall mean A,—two dots together, B,—three together, C,—and so on. Some of the letters can be made of dots and lines. Thus D can be a line and a dot. In this way, they can go on and make up a whole alphabet. Now if the man in New York wants to send a message here, he does it in this way. Suppose the first letter in his message is A. He makes a little spark of lightning go from his office over the wire. The machine in the office here is fixed in such a way, that the lightning as it comes here can make a dot on a piece of paper. If the next letter is C, he sends three sparks of lightning, one right after the other, so that three dots are made on the paper close to each other. And so you can see how he could make any letter that he wishes.

If you go into a telegraphic office, you hear a clicking noise all the time. This is caused by the working of the machine. Some persons get so used to the machine that they do not need to look at the dots and lines that it makes. They can tell what the messages are by hearing the clicking. They have learned the alphabet pretty well, we should say.

In another way that they have of working the telegraph, such letters as we use are printed. The lightning is really made to turn printer. The machines are made in such a way, that when the lightning comes over the wires into an office, it prints letters on a strip of paper. The man that sends the message, sits before a machine that has keys like a piano. If he touches the key of the letter A, this letter is printed as quick as lightning, as we say, in the place that he is sending the message to. And it is the same way with the other letters. How strange it is that a man in an office here can print in New York, or Philadelphia, or any other place to which the wires go.

Suppose that a message is to be sent on from New York through New Haven to Boston. How do you think they do it? The man in the New York office makes the lightning tell the man in New Haven, that he wants to send a message on to Boston. The New Haven man hooks the wire from New York on to one that goes to Boston. Then the New York man can send the lightning over the wire right on to Boston without having it stop in New Haven.

What ideas do some people have of the telegraph? Tell about the boots. What gives the messages? What is one way of doing this? Tell how the alphabet may be made? Tell how it is used? What is the clicking sound that you hear in a telegraph office? What is said about some that are used to hearing this? Tell about another way of giving the messages. In what way can a message be sent from New York through New Haven to Boston?

CHAPTER XLI.

BRICKS AND EARTHENWARE.

BRICKS are made mostly of clay. I will tell you how it is done. First the clay is well broken up. I have seen this done by driving cattle round and round in the clay. At the same time it is well moistened by pouring water on it. After it is trodden enough in this way, it is made into the shape of bricks.

These bricks are quite soft. You will want to know how they become hard. They are first well dried in the sun. But this does not make them hard enough. After drying them they burn them. They are burned in this way. The bricks are piled up very carefully with spaces between them. A fire is made under the pile. The heat goes up through all the spaces, and so the bricks are burnt. They are now hard enough to use in building houses.

The clay that bricks are made of is not at all red. Why, then, do most bricks have this color? It is because there is some iron mixed up with the clay. It is the heat in burning the bricks that makes the iron give the red color to them. How curious it is

that what makes your blood red, as I told you in Chapter XXII, makes bricks red also !

Perhaps you have read in the Bible how the children of Israel made bricks in Egypt. They used straw in making their bricks. The straw was cut up and mixed with the clay. These were not such bricks as are used in building our houses. They were only dried. They were not burnt. The straw would be of no use in bricks that were to be burnt, for it would burn up and be lost.

The bricks that were made in this way were harder than you would suppose they could be. They were used in building just as our bricks are. Do you see of what use the straw was in them ? Without it the bricks would be brittle, and would break easily. The pieces of straw bind the clay together. It does the same for clay as I told you in Chapter XIV hair does for mortar. Bricks that are burned do not



Fig. 1.

need anything to bind the clay together, because the heat makes them so hard.

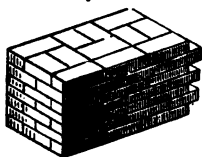


Fig. 2.

Did you ever think how bricks are laid in building a wall. They do not lay them one top of one another, as in Fig. 1. But each brick lies on two bricks, as you see in Fig. 2. This makes the wall hold together well. You can see the difference if you lay the blocks that you play with in both ways. When the blocks are

laid as in Fig. 1, they can be knocked over more easily than when they are laid as in Fig. 2.

Many other things besides bricks are made of clay. Tobacco pipes are made of clay. These are baked. They are not burnt as bricks are.

All earthenware is made of clay. If you go into a pottery, you can see how the workmen shape the jars and jugs and mugs, as they make them out of the soft moist clay. After they are made they are left to get dry. Then they are baked like the tobacco pipes. The clay of which such things are made is finer than that of which they make bricks.

Some earthenware is glazed, as it is called. It is made very smooth and hard. How this is done, you can understand when you are a little older. Flower pots are commonly not glazed, because they do not need it.

If the ware is not glazed, the moisture can come through it some. It comes through fine holes, or pores, as they are called. These pores are so fine that you can not see them, but a flower pot is always a little moist on the outside, from the water that comes through from the dirt inside.

It is well enough to have flower pots without glazing. But it would not do for jugs and jars. We should not like to have what we put in them oozing through the pores. So we have the pores shut up by the glazing. If we should put preserves into jars that are not glazed, the moisture would all

come out through the pores, and the preserves would in a little time be dry. But such jars are always glazed, and this does not happen.

The clay that teacups and saucers and other nice things are made of, is finer and better than the clay from which they make jugs and flower pots. The very best clay is used in making the whitest china ware.

What are bricks made of? How is the clay prepared? After it is made in brick shapes, what is done with them? What next? In what way are they burned? What is the color of bricks before they are burned? Why are they red after they are burned? What in you is made red by iron? How did the children of Israel use straw in making bricks in Egypt? How were their bricks made hard? Why would straw be of no use in making burnt bricks? Of what use is the straw in bricks made hard only by drying? What is there that is of the same use in mortar? Tell how bricks are laid, and why. Tell about tobacco pipes. And about earthenware. What things are commonly not glazed? Tell about the pores in them. Why are jugs and jars glazed? What would happen to preserves if they were put in unglazed jars? What things are made out of very nice clay?

CHAPTER XLII.

GLASS.

GLASS is made mostly from sand, or flints and other stones. It can not be made out of these alone. Some other things are mixed with them. Potash is one of these things.

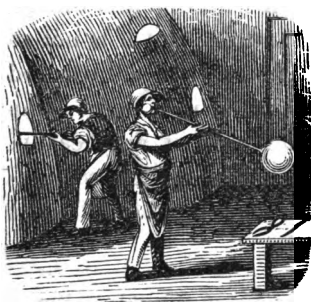
In making glass, the sand, or the powder of flints and some other stones, is heated in a very hot furnace. But it would not melt at all with the very hottest fire, unless the potash were put in with it. It is this that turns the sand into melted glass. While this is going on there rises a sort of scum. This the workmen skim off with large ladles and throw it away. If they did not do this, the glass would not be clear and smooth.

Out of this melted glass all sorts of things are made,—tumblers, pitchers, jars, cups, bottles, window glass, and so on. You would like to go into a glass-factory, and see how all this is done. I will tell you a little about how some of the things are made.

It is curious to see how they make a bottle. A man has a long iron rod. It has a hole all the way through it like a pipe-stem. He puts one end of

this rod into the melted glass in the furnace, and gathers up a little of it. As he takes the rod out, the glass on the end of it is red hot, and does not look anything like a bottle. But he makes a bottle of it in a very few minutes. He does it in this way. He blows through the iron tube. This makes the glass hollow. He then with a piece of iron shapes it into a bottle. He can do this because the glass is quite soft so long as it is very hot. In the same way he makes decanters. Tumblers are blown in the same way, but they have to manage differently to give them their shape.

The way that they make window glass is very pretty. The man with his iron tube gathers up a



good deal of the melted glass. He then blows it very hard so as to make a large hollow ball. Here is a man blowing such a ball of glass. But you will ask how flat panes of glass can be made out of this ball. The ball is

changed into a flat round plate of glass before it is cut up into window glass. How they manage to do this you can not understand till you are a little older.

They cut up the glass into panes with a diamond. This is the only thing that is hard enough to cut glass. The diamond is very small, and is fastened

nicely on the end of a stick so that it may be used conveniently. Sometimes in fitting a pane of glass into a window, the glazier is obliged to cut off some of it, and he does it with a diamond. You remember that in Chapter XIII, I told you how the chicken cuts its way out of its egg-shell. The diamond used in cutting glass made me think of the chicken's shell-cutter on the end of its bill. But this is nothing like as hard as the diamond, for egg-shell is cut much more easily than glass is.

Very large plates of glass are not made in the same way that window glass is. These are made in copper pans. The melted glass is poured into these pans and is left to cool there. Afterward the glass is made very smooth by rubbing it with different things.

Glass, you know, is very brittle. But it is not so when it is made red hot. If you hold a little rod of glass, or any slender piece of it, in a spirit lamp till you see it is red, you can bend it very easily. Melted glass can be drawn out, like melted sealing-wax, as fine as hair. I have seen bundles of glass hair that were very beautiful.

What is glass made of? What must be put with these things to make glass of them? How is the glass made? Tell about the scum. What are some of the articles made of glass? Tell how a bottle is made. Tell about making tumblers. How is window glass made? With what is the glass cut up into panes? How is the diamond used in cutting it? What is this like? Can the chicken's shell-cutter cut glass? How are large plates of glass made? Tell about bending glass. Tell about drawing it out like hairs.

CHAPTER XLIII.

DIFFERENT WAYS OF TRAVELING.

THERE are some ways of traveling that are very slow, and some that are very fast. A man traveling on foot can go about three miles in an hour. But in the cars on a railroad we sometimes go ten times as fast. How many miles in an hour would ten times as fast be?

It is only a little while since they began to build railroads. Before they were built, people used to travel much in stages. This was rather a slow way of traveling. We can go forty miles in the cars while a stage is going ten miles. Traveling in a stage, too, was uncomfortable. Nine people were crowded into a small stage. But in a railroad car there is a plenty of room, and the seats are very comfortable.

Traveling in a steamboat is quick, but it is not as quick as traveling on a railroad. Traveling in a canal boat is slow, because the boats are drawn by horses going along on the banks of the canal. Traveling in a sailing ship is very fast when the wind is strong and blows in the right way. But sometimes

there is no wind at all. Then the ship is still in one place. And when the wind blows the wrong way, we go back instead of forward. But with steam we can always go along. Even when we go against the wind we go quite fast, unless the wind is very strong indeed.

Small sail-boats and row-boats are often used when people wish to go only a little way on the water. You have perhaps heard of the canoes that the Indians used before white people taught them how to



make boats. A canoe is made out of a log. The log is dug out so as to make it a long trough-like thing.

In some countries mules are used instead of horses. They are very useful indeed in traveling where there are rocks and mountains. They are very sure-footed. The mule will carry a man on his back very safely in places where a horse could not go at all.

In Lapland, which is a very cold country, the in-

habitants use reindeer for traveling. On the opposite page is a picture, showing how they do it. The Laplander is in a sledge, as it is called. You see that it is made something like a boat. In this the reindeer will carry him very fast over the ice and snow. He goes so fast, that whenever we wish to speak of a horse or anything as going very swiftly, we say as swift as a deer, or like a deer.

Horses could not live in such a cold country. There is no grass for them to eat, and very little of anything grows there. But the reindeer can live on moss and the leaves of trees.

In some very cold countries, dogs are used in traveling. You have, perhaps, seen pictures of men drawn on sledges by a long team of dogs.

Persons that travel on foot in countries where there is a great deal of snow and no roads, wear snow-shoes. These are made of something very light indeed ; commonly it is a kind of basket work. They are made very broad and long, so as to press on a good deal of the snow. The reason of this you can see. You know that your feet sink into the snow very easily. But lay a light board on top of the snow, and you can stand on this. It will not sink into the snow, because it presses on so much more of the snow than your feet do. It is just so with the snow shoes.

In those countries where elephants are found, they are used in traveling. A large box-like saddle is

fastened upon the elephant's back. This box has seats in it for several persons. Sometimes a sort of covered house is used instead of an open box.

The camel is very useful for traveling. He is better fitted for going across a desert than any other animal. You know that in a desert there is no water to be found. Now the camel can go a long time without drinking. This is because he has a large bag inside of him, where he can as he drinks put in water enough for a long journey. When he is thirsty, all that he has to do is to squeeze this bag and then some of the water goes out of it into his stomach. God made this animal in such a way on purpose to fit him to travel over deserts.

How fast can a man travel on foot? How much faster in the cars? Is it long since railroads were first built? In what way was it common for people to travel before this? In what two things is railroad traveling better than stage traveling? What is said about traveling in a steamboat? And in a canal boat? Tell about traveling in a sailing ship? Why is it better to go in a steamship? When are small sail-boats and row-boats used? Tell how an Indian's canoe is made. Why are mules sometimes better than horses? Tell about traveling with the reindeer. And with dogs. What are snow-shoes? Tell about the board on the snow. How is this like the snow-shoes? How are elephants used for traveling? What is the camel better fitted for than any other animal? How is he fitted for it?



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